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The Engineer

JANUARY 14, 1955 — 28, ESSEX ST., STRAND, LONDON, W.C.2 — TWO SHILLINGS

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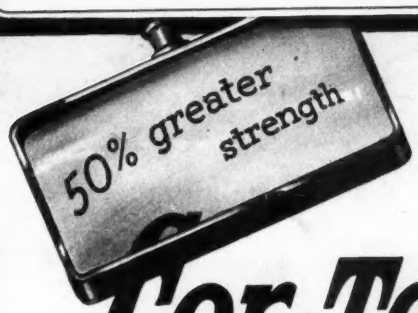

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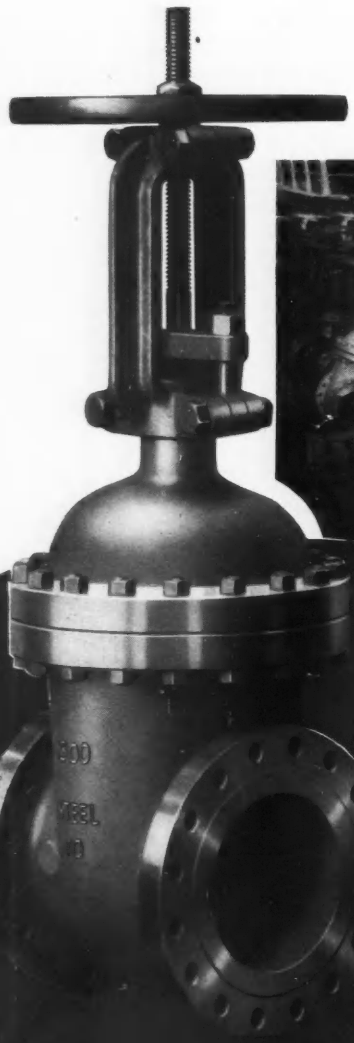

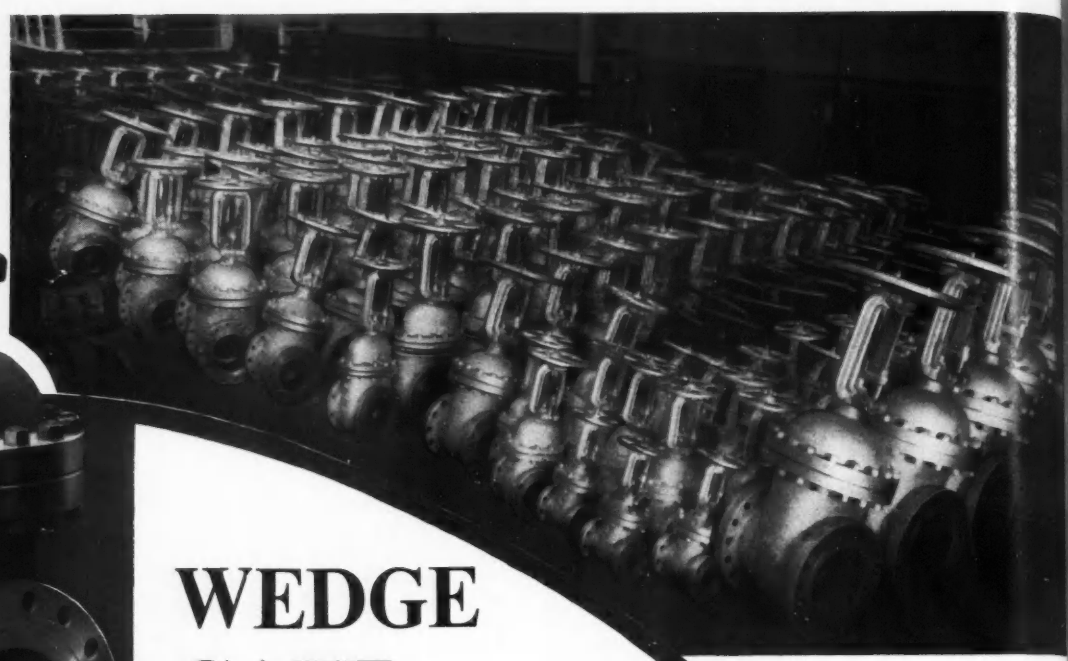

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THE ENGINEER

JANUARY 14, 1955

Railway Operating and Motive Power Resources

AN interesting and informative paper dealing with the economics of intensified use of railway operating and motive power resources was presented at a meeting of the Institute of Transport, in London, on Monday last, by Mr. H. H. Phillips. Mr. Phillips is the assistant general manager, British Railways (Western Region). In his paper he assessed the present utilisation of railway resources in this country and also discussed the possibilities of improved utilisation. Mr. Phillips explained that British Railways possessed about 19,000 locomotives of various kinds, nearly 53,000 passenger train vehicles, and over 1,000,000 freight wagons, the book value of all of which equipment was over £500 million. The expenditure incurred in the running and maintenance of rolling stock, he said, probably accounted for more than half of British Railways' total expenditure, which last year was £386 million. The question of utilisation therefore occupied an important place in the British Transport Commission's efforts to secure greater productivity. In his assessment of the situation, Mr. Phillips pointed out that locomotives spent almost two-thirds of their life in motive power depots or repair workshops, the period in payload movement probably amounting to less than seven hours a day. Drivers, he added, spent about five hours a day on the footplate of engines in traffic, and wagons were carrying loads in train movement for slightly less than fifty-five minutes a day. Passenger train stock was attached to a train engine for not more than 4½ hours a day, the period of revenue earning movement probably being much smaller. Certainly, Mr. Phillips continued, some unproductive time was inseparable from railway working, but the figures suggested that there was a considerable amount of slack waiting to be taken up if ways and means of doing so could be found. A good deal of the cost of manpower and rolling stock was incurred on a time basis irrespective of whether the resources were idle or in use. It was clear, therefore, Mr. Phillips commented, that the conversion of idleness into revenue-earning employment offered a field for substantial economies, either by the provision of additional facilities and therefore greater revenue-earning capacity at proportionately lower cost, or else by the performance of the present volume of work with fewer men and less equipment.

Exhibitions at the Science Museum

DETAILS of new items and equipment concerning two exhibitions at the Science Museum, South Kensington, have been announced. From January 25th the collection of fire-fighting appliances which has been in dispersed storage since the war, is to be reopened to the public. In addition to the original collection of historic equipment, there will be displayed some more recent acquisitions including a full-sized steam fire engine and other model engines. One of those models is an original model manual fire engine dating from 1680, which will serve as the final of a series of exhibits illustrating the development of the fire engine. The exhibition will cover the development of other apparatus, such as alarms and extinguishers. The other exhibition consists of a working model of a complete steel works, which has been lent to the Museum by the British Iron and Steel Federation. It will be demonstrated and explained at intervals and a selection of the most recent films on various aspects of the iron and steel industry will be shown. It stands on a floor area of 60ft by 24ft and portrays a steel works covering a site of over a quarter of a square mile in area, with a weekly capacity of 10,000 tons. The purpose of the model is educational, to show how the various pieces of steelmaking plant are arranged in process sequence from the iron ore to the finished product. Raw materials are unloaded at the docks by transporter crane and, together with coke from the coke ovens, charged into the blast-furnaces. There follow in sequence steelmaking furnaces, ingot casting bays, soaking pits and rolling mills. Ancillary services, such as a power station, repair shops, stockyards, twenty miniature locomotives and 1500 pieces of rolling stock running on half a mile of track, complete the scene. It will be on view from January 25th onwards. Admission is free to both collections and the hours of opening are between 10 a.m. to 6 p.m. on weekdays and 2.30 to 6 p.m. on Sundays.

Proposed Clifton Bridge, Nottingham

A PRESTRESSED concrete bridge with a main span of 275ft is to be built over the Trent at Nottingham. The future road programme of this area envisages a trunk road dual carriageway crossing the Trent near the Clifton Estate, but it has been decided by the city council not to await the building of the trunk road but to construct a bridge which will serve for immediate needs and still constitute an instalment of the trunk road scheme, giving facilities for a 22ft carriageway, a 9ft cycle track and a 6ft footpath. Periodic flooding of the River Trent necessitated careful model studies by the River Board and has resulted in certain requirements for minimum flood interference over the low-lying area on each side of the river; the embankment on the north side of the bridge is thus broken by three 40ft span viaducts some 1000ft to the north of the river bank, and the crossing of the river itself has been made in a single span. On the south side three 90ft span viaducts carry the roadway over low-lying ground. The works envisaged at present comprise the construction of the three 40ft span north viaducts, the main bridge with a main central span of 275ft and two side spans of 125ft and the south viaducts with three spans of 90ft. Thus, the total continuous length, excluding the north viaducts, is 795ft. Each of the north viaducts is to consist of sixteen precast "H"-beams 2ft 6in deep and post-tensioned by the Lee-McCall system. The beams will be lifted into position and a reinforced concrete deck slab will be cast over the beams, the space between the beams being covered by precast planks which form a permanent shuttering to the deck slab. The beams are to be connected by precast transverse diaphragms, prestressed after assembly. Each of the south viaducts is to consist of seven "T"-beams 5ft 6in deep, the beams being cast on site and prestressed by the Magnel-Blaton system. The space between the tee flanges of the beams will be filled with *in situ* concrete, forming, with the flanges, the deck slab, which will be transversely prestressed. Diaphragms will connect the beams at intervals along their length and transverse prestress will be used in the diaphragms. The beam-diaphragm system is designed as a grillage. The main bridge is to consist of two balanced cantilevers each comprising an 87ft 6in cantilever and a 125ft "tailing down" or end span. The main central span of 275ft will be completed by a 100ft suspended span joining the two cantilevers. Two kinds of construction are to be used for the main bridge. The cantilevers and end spans will be cellular in cross-section and cast *in situ*. The end span will be cast on falsework and it is proposed that the cantilever be constructed by "cantilevering out." The suspended span will consist of seven "T"-beams, precast on site and partially prestressed. After their erection on the ends of the cantilevers, the deck is to be constructed similarly to the south viaducts, with *in situ* concrete joining the flanges of the beams; then further longitudinal and transverse prestress is to be applied. The Magnel-Blaton system will be used for the main bridge. Reinforced concrete earth retaining abutments are to be used at the extremities of the 795ft "run" and at the junction of the main bridge and south viaducts a cellular pier will provide bearings for both the end span and first viaduct. The works are under the direction of the city engineer, Mr. R. M. Finch. The north and south viaducts are being designed in the city engineer's department, and the consulting engineers for the main bridge are Messrs. R. Travers Morgan and Partners. The contractor is James Miller and Partners, Ltd. It is expected that work will start this month.

Hydraulic Study of Flooding in the River Trent

THE Hydraulics Research Station, D.S.I.R., has contracted to carry out an investigation for the Trent River Board to study means of alleviating flooding in the tidal reaches of the River Trent between Newark and the point where the Trent enters the Humber at Trent Falls. Between Newark and Gainsborough, flooding may be caused by an excessive upland fresh-water discharge; between Gainsborough and Trent Falls, flooding may be due either to the combination of a large upland river discharge and a high tide, or to a storm surge superimposed upon the tide. To investigate the interaction of these various flood conditions, and to test methods of preventing or reducing flooding in the future, a model, some 270ft long, is to be constructed in the new main hall at the Hydraulics Research Station. The horizontal scale of the model will be 1/800, and the vertical scale 1/72. Tides will be generated by a pneumatic displacer with an electronic servo-control. Data on tides, flows, bed materials, suspended load and salinities have been collected by the Trent River Board, and the design of the model and its associated equipment is now in progress at the Hydraulics Research Station at Wallingford. Construction of the model is expected to start early this year.

Packaging Exhibition

THE Packaging Exhibition will be opened at Olympia in London on Tuesday next, January 18th, by Captain H. F. C. Crookshank, the Lord Privy Seal, and will be continued daily until Friday, January 28th. This exhibition is organised in collaboration with the Institute of Packaging and will be the largest of its kind yet held. Some 200 firms will be showing a comprehensive selection of the latest packaging materials, methods and machines for all classes of goods. The materials will include those for purely protective purposes, such as are required for the transport and storage of goods under unfavourable conditions in the Tropics, and those incorporating attractive designs to promote sales as well as to protect the contents of the package. Other exhibits will show the complete services which are now provided by firms specialising in packing goods and the methods and materials they use to avoid damage caused by handling, transport and storage. Various designs of automatic machines will also be shown in operation packing foodstuffs, sweets and consumer goods. At a convention arranged by the Institute of Packaging, which will be held in conjunction with the exhibition, the following papers will be presented for discussion:—"World Marketing Conditions," by Mr. F. C. Hooper; "International Transport Hazards," by Mr. J. J. Ferriggi; "Should the Product Fit the Package?" by Mr. F. A. Paine; and "Cutting Costs in the Packaging Line," by Mr. G. D. Sanderson.

Civil Engineering in 1954

No. II—(*Continued from page* 12, *January 7th*)

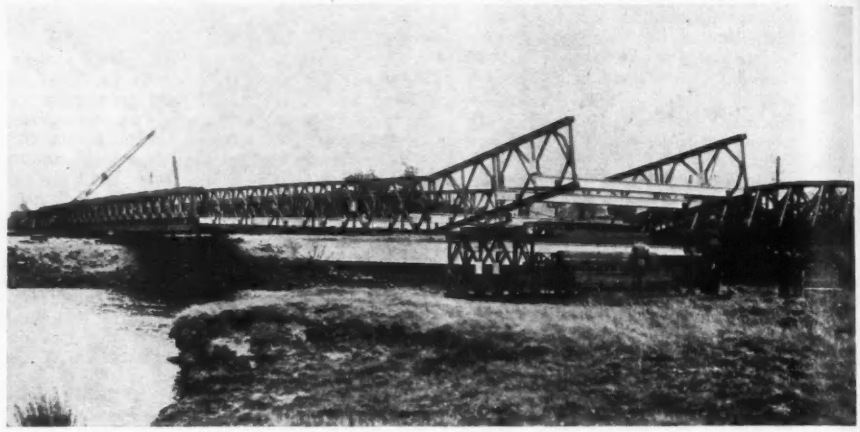
IN our annual review of civil engineering published last January, we were able to record a statement by the Minister of Transport and Civil Aviation that certain limited road schemes were to be started ; works totalling £19,000,000 of Government expenditure over the whole period of their execution would be authorised in the next financial year, it was then stated. During 1954, apparently the only portion of these works upon which a start was made comprised a contract for a second carriageway on certain sections of the Stafford–Stoke road A34, a contract for the Loughton by-pass A5, and one for a second carriageway on a section of the Great Cambridge road A10. These three contracts total about £370,000 in value. A contract of about the same value as the total just given is to be let by the London County Council soon, for the Cromwell Road extension. The total value of trunk road contracts in progress during 1954, with which the Ministry was concerned, was about £3,500,000, more than half of this amount being the cost of the Neath by-pass bridge and viaduct.

National concern over the inadequacy of Britain's roads was, if anything, even more pronounced in 1954 than in the previous year. In at least partial recognition of this situation, the Government announced, in the Queen's Speech last December, that it had " decided to embark upon an expanded programme of road construction and improvement, designed both to increase safety on the roads and to promote the freer flow of traffic." Sir Anthony Eden gave some details of this programme, which, he said, would be " as much as two or three times the amount allowed by the present programme," i.e. a maximum expenditure of about £45,000,000 annually. In a leading article discussing the Queen's Speech (THE ENGINEER, December 10th) we questioned whether this expenditure would prove nearly sufficient, and pointed out that road traffic was expanding so rapidly that it might do little more than prevent road conditions becoming worse.

There was, therefore, practically no new construction in 1954, which could be mentioned in this review ; for examples of highway construction we have to look to other countries, such as the United States ; some American roads of 1954 are illustrated on Plate 14. There were, however, a number of road and road bridge schemes in progress overseas during 1954, for which British consultants were responsible. We exemplify this work by giving some details of the road from Dar-es-Salaam to Morogoro in Tanganyika. This road is 120 miles long and was completed in 1954 and opened to traffic. It will replace an old road, some distance to the south, which invariably became unusable during the rainy seasons owing to flooding of the Ruvu River. Originally planned as an all-weather road with a bitumenised surface for the carriageway, 18ft in width, it was found necessary to exercise economy soon after work commenced towards the middle of 1951 owing to the rising costs of construction. As a result only about one-quarter of the length was finished as planned ; the remainder was constructed as a gravel road which will be raised to the desired standard when funds permit.

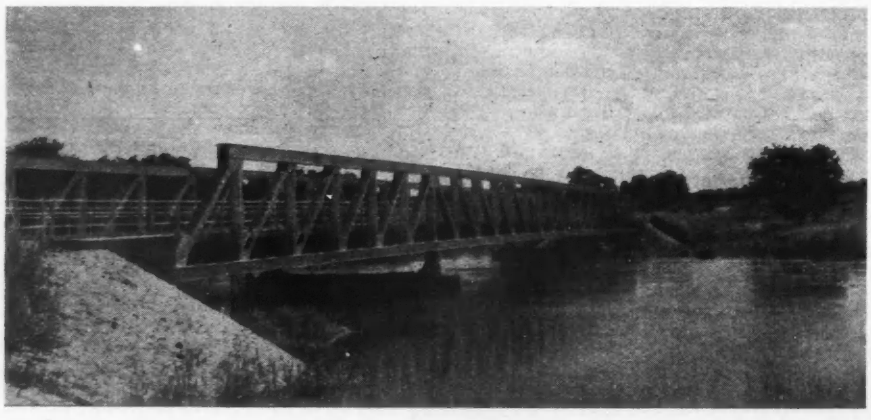
The first 40 miles of the road, between Dar-es-Salaam and the Ruvu River presented quite a number of problems. Over some 25 miles of this section soil conditions were found to be extremely difficult, and it was only possible to provide a stabilised surface by bringing in materials from some appreciable distance. The Ruvu River lies in a plain, varying in width from 1 to 2 miles, the whole of which is subject to flooding. A three-span continuous girder steel bridge, 336ft long, and illustrated herewith, carries the road over the river itself, whilst the approach embankment is provided with flood relief culverts at intervals. As an additional precaution the embankment was dished to permit overtopping at a controlled point in the event of excessive flooding. The consulting engineers for this work were Sir Alexander Gibb and Partners.

Before leaving the subject of roads, brief mention should be made of an interesting military development of the year. The Army's new heavy girder bridge, illustrated herewith, some details of which were released, was designed at the request of the War Office by the Military Engineering Experimental Establishment of the Ministry of Supply. The need for military bridges capable of taking larger and heavier fighting vehicles was met at the close of the second world war by modifications of the well-known and well-tried Bailey bridge, and components were designed and produced to enable stronger and wider Bailey bridges to be constructed. It soon became evident, however, that further adaptation of the smaller bridge to carry still heavier loads would be uneconomical in material, transport and manpower.



The Army's new heavy girder bridge. The bridge is designed to carry the heaviest military loads over wide spans. Building and launching of the first bridge is shown here

The components of the Bailey bridge are all small enough to permit construction entirely by hand, but in planning the design of the heavier bridge it was decided that the use of mechanical aids would be acceptable. Cranes and compressor-driven winches will normally be used in building the heavy girder bridge, although hand construction will still be possible in an emergency. The panels of the new bridge closely resemble the familiar Bailey panel, but are larger and heavier. The equipment is designed to carry the heaviest military loads over wide spans. A special feature is a construction method which makes it possible to assemble complete bays of bridge, one panel long, under cover well behind the bridging site and to bring them up on bogies ready to be built into the bridge.



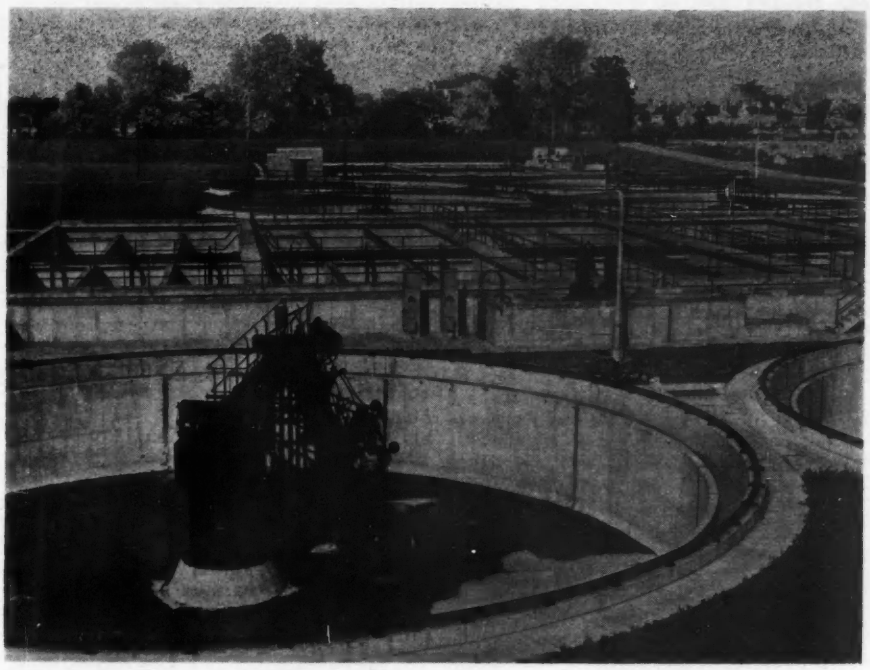
Ruvu bridge, a three-span continuous girder bridge, 336ft long, forming part of the road between Dar-es-Salaam and Morogoro, in Tanganyika

AIRPORTS

The first British airport—Ferryfield—to be built for an independent airline was completed in 1954 at Lydd, near Dungeness, for Silver City Airways, Ltd. It has two runways forming an " X," the principal one being 120ft wide and 4050ft in effective length ; the second runway is 3500ft long. The runways consist of stabilised gravel base course, with a compacted depth of 6in and a cement content of 7 per cent, and a surfacing

carpet of 1½in of tar macadam. When the runways were on clay a gravel base not less than 27in thick was constructed.

An airport was also completed during the year at Dar-es-Salaam in Tanganyika. Again, there is a main and a secondary runway, the total runway thickness being 10in. The main runway is 6800ft long and 150ft wide and is designed for twin-wheel undercarriage aircraft as heavy as the "Stratocruiser," and four-wheeled types as heavy as the "Comet III." The secondary runway is 3300ft long and 100ft wide, and is intended for aircraft of the weight of the "Viking," with occasional heavier loading. Construction included 1,500,000 cubic yards of earthworks, with up to 25ft of fill and 13ft of cutting, and the removal of anthills with clay bases up to 60ft in diameter and 10ft deep. Special attention was paid to the proper compaction of both soil and stone, and a site laboratory was maintained throughout the work, and used especially for continuous control of compaction densities, soil and stone grading, and similar tests. The consulting engineers were Sir Alexander Gibb and Partners, and the contractor was the Tanganyika Engineering and Contracting Company (1950), Ltd.

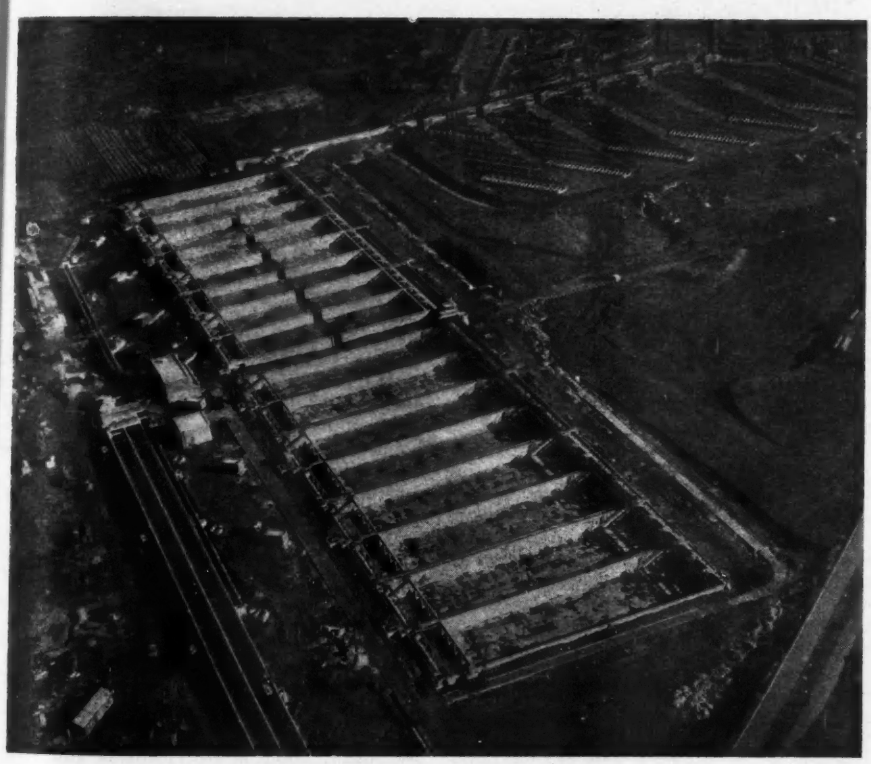


Peterborough sewage purification works. The final tanks are in the foreground; behind them may be seen the aeration and primary tanks. The rectangular storm water tanks are in the background with the sewage inlet works to the right of them

City Planning

During 1954 considerable progress was made with rebuilding war-damaged areas in the City of London. This work was in full swing after a wait of several years, when no licences had been allowed for such work. Although such action is welcome it has not been without criticism, for the areas concerned are being "rebuilt" rather than "replanned," and no comprehensive replanning schemes have been attempted up to now, although there were discussions going on at the end of the year about the future of the Barbican-Aldersgate area.

The most obvious defect in the rebuilding work is that there is no provision for better road communications. But this is only one aspect of the planning of a city, and there are many points of view about the best way to use the congested central areas. The Institution of Civil Engineers' symposium on high buildings, held last December, was thus of topical interest and provided a most interesting discussion of these problems. The symposium was based on the idea of a large structure, such as the proposed High Paddington scheme, capable of accommodating the entire amenities of a town of about 8000 persons. The symposium was fully discussed in THE ENGINEER at the time, but it is worthy of mention again here because a great deal of engineering design and research work was in fact carried out during 1954 to ascertain the practicability of the High Paddington scheme. A cross-section of the foundation design was reproduced in our issue of December 17th, as part of an abstract of one of the papers of the symposium. The project envisages a broad base nearly 100ft in height, built over Paddington goods yard, with parts of the building rising above it to about 350ft, or thirty-eight stories. The project has not yet been officially adopted or given planning permission.



Sixteen sedimentation tanks at the London County Council's northern outfall works. The by-pass culvert from the main effluent channel is shown to the left of the tanks, with the early works for the new activated sludge plant in the background. The existing activated sludge plant is shown in the right background

Sewage Purification

We illustrate on Plate 3 the Rye Meads sewage purification works in the Lea Valley. Rye Meads was one of the major schemes of this kind under construction during 1954, and by the end of the year construction was well advanced. Work on a large scale was also in progress at the London County Council's Northern Outfall works at Beckton, E.6. We illustrate sixteen sedimentation tanks, the construction of which was almost completed, which form one stage of a major scheme at the Northern Outfall. Work was also started there on the construction of a diffused air activated sludge plant, comprising six sets of aeration channels, fifteen final settling tanks, air mains, sludge mains, pumping station and control house. The substructure of a works power station, which will be powered by eight gas turbines, was also started, and contracts for a sludge digestion plant with sixteen digestion tanks, four dewatering tanks, secondary digestion tanks and pumping stations, are to be let this year. The whole scheme is due for completion in 1958; it is being built under the direction of the chief engineer of the London County Council, and the civil engineering contractor for the sedimentation tanks is Edmund Nuttall, Sons and Co. (London), Ltd., and for the diffused air

plant and power-house substructure, Richard Costain, Ltd.

As an example of a purification works on a smaller scale, we illustrate on page 43 the new works at Peterborough, which was almost completed during the year, although some main sewers have yet to be built. The works is designed to deal with the sewage from a population of 61,500 in the City and 8500 from Peterborough Rural District, giving a dry weather flow of 2·7 m.g.d. In wet weather three times the dry weather flow will receive full purification treatment and the remainder will pass to stormwater tanks.

The works consist of constant velocity grit channels with grit pumps, comminuters, circular sedimentation tanks with sludge scraping mechanisms, activated sludge channels with dome diffusers, circular flat bottom final tanks with suction sludge removal machines, rectangular stormwater tanks and sludge drying beds. The sludge resulting from the treatment plant will be pumped to six digestion tanks, from three of which gas will be collected in floating holders. The power-house will house a triple-ram pump for pumping digested sludge to the drying beds, sludge recirculation pumps, and also dual-fuel engines which are direct coupled to rotary blowers providing air for the activated sludge process. The cooling water from the engines will be passed through coils in the primary digestion tanks, thus cooling the water and heating the sludge. This heat can be augmented in cold weather by gas-fired boilers or reduced in hot weather by heat exchangers using sewage effluent as the coolant.

The grit pumps, comminuters, sludge scrapers, &c., will be driven by small motors supplied with power from the grid. The final effluent, after gauging, will be discharged to the tidal portion of the River Nene. Considerable quantities of hard cornbrash rock (a limestone) which required blasting, were encountered in the foundations for several of the purification units. The works is situated on low-lying ground, and a berm was built around part of its perimeter for flood protection. The consulting engineers were Messrs. J. D. and D. M. Watson, and the contractors for the civil engineering, and the various items of plant were Holland & Hannen and Cubitts, Ltd.; M. J. Gleeson (Contractors), Ltd.; B. Stokeley; the National Gas and Oil Engine Company, Ltd.; W. E. Farrer and Sons, Ltd.; Gwynnes Pumps, Ltd., and Ames Crosta Mills and Co., Ltd.

Technical Report

Drilling Titanium Alloy Ti 150 A. Production Engineering Research Association of Great Britain, Staveley Lodge, Melton Mowbray.—The object of this investigation was to determine the effect of point shape angle, cutting speed, feed rate and cutting fluid on the performance of high-speed steel drills when drilling titanium alloy Ti 150A.

The conclusions reached as a result of the investigation were as follows :—The drill point angle and relief angle had marked effects on drill life. Superior results were obtained using a 105 deg. point angle and a 10 deg. relief angle. The drill life obtained using drills with a 25 deg. helix angle was superior to the drill life obtained when using drills with 10 deg. and 42 deg. helix angles. There was a marked reduction in drill life when cutting speeds and feed rates above 64ft per minute and 0·0014in per revolution respectively were used. When using a cutting fluid consisting of one part mineral oil, five parts soluble oil and eighteen parts water the drill life was ten times greater than that obtained using a sulphurised neat oil and forty times greater than that obtained using soluble oil at 1 : 20 dilution. There was no evidence to suggest that difficulties in drilling and facing titanium alloy Ti 150A were associated with work hardening characteristics of the material.

The Royal Navy in 1954

BY OUR NAVAL CORRESPONDENT

No. II—(*Concluded from page 4, January 7th*)

Naval Aviation

HAVING regard to our past neglect of naval aviation since the war it is pleasing to record marked progress during 1954 in the equipment of the Fleet Air Arm with jet machines. Apart from anti-submarine Fairey "Gannets" and helicopters, which are now coming into service, the Fleet Air Arm has at the present time five squadrons of "Sea Hawks," two of "Sea Venoms," one squadron of "Attackers" and one squadron of Wyvern airscrew-turbine strike aircraft. This is indeed progress, but none the less it is a miserably small force to have built up during the nine years since the first deck landing by a British jet fighter. All are straight-wing machines with centrifugal flow gas turbines and are already obsolescent. Yet the swept wing fighter has been supplied in quantity to the R.A.F. and has been in service in the United States Navy for over four years. Some 200 "Sea Hawks" have been ordered under U.S. off-shore procurement funds. It is to be hoped that these are intended for other N.A.T.O. countries, as it is essential that the Fleet Air Arm should press on with the Supermarine "525" and the D.H. "110." The former, a swept wing twin-jet day interceptor, is credited with being the fastest and most powerful aircraft ever designed for carrier work, and has at last flown. But little has yet been heard of the D.H. "110," an all-weather fighter with a top speed of about 700 m.p.h. At the moment these two fighters look like being able to protect the fleet against any aircraft likely to attack it, but whether this will be true by the time they come into service is another story. The first squadron of Wyvern strike aircraft has now been embarked in the "Albion" for service in the Mediterranean, but pending the production of a torpedo for dropping from high-speed aircraft, there seems some doubt about the role intended for these aircraft. They are armed with four 20mm guns and fitted to carry a torpedo, bombs, depth charges or rockets.

The Fleet Air Arm is also to have two types of first-rate anti-submarine aircraft in the Fairey "Gannet" and the "Seamew," and it is hoped that the four squadrons of "Avengers," an obsolete United States aircraft on which we have been relying for anti-submarine operations, will soon no longer be seen with the Fleet. The "Gannet," with twin "Mamba" engines—one can be shut down when cruising—has a large endurance and is equipped with search radar and sonobuoys and with the necessary armament for destroying submarines. The fact that her engines operate on the ship's oil fuel also does much to simplify the fuel storage problem in carriers. The first squadron of "Gannets" was formed last September and at least two more are in process of formation. The "Seamew," designed by Short Brothers and Harland, is not yet in service. This is a light, simply constructed anti-submarine aircraft specially designed for operating from escort and other small carriers. It can land at very low speed and take-off from a minimum of space. A squadron of "Whirlwind" helicopters was also formed last year for anti-submarine duties. For anti-submarine work helicopters possess the unique advantage of being able to fly very slowly and to hover over a submarine. They are also capable of being operated from the deck of a medium-sized merchant ship. At the moment they have limited range and carrying capacity and though the U.S. Navy's "Bell H.S. L-1" and the twin-engined "Bristol 173" now under trial can carry both detection and destruction equipment, helicopters in the immediate future will probably be used primarily for detection, working in conjunction with fixed wing aircraft or surface forces. A number of twin-rotor "Bell H.S.L.-1" have been ordered for the Royal Navy. They are fitted with search radar, sonobuoys and a formidable anti-submarine armament and will provide a welcome addition to our anti-submarine defence measures, pending the production of the "Bristol 173," of which 100 have already been ordered. The recruiting of pilots and aircrews still leaves much to be desired. Apart from the regular officer who may volunteer, entry is by means of four-year or eight-year short service commission or on a national service commission, which do not offer the definite prospect of a life-long naval career. Some fifty pilots of the Fleet

Naval "Whirlwind S55" helicopter

Air Arm are doing their basic flying training at Pensacola in Florida, under the N.A.T.O. mutual defence assistance pact.

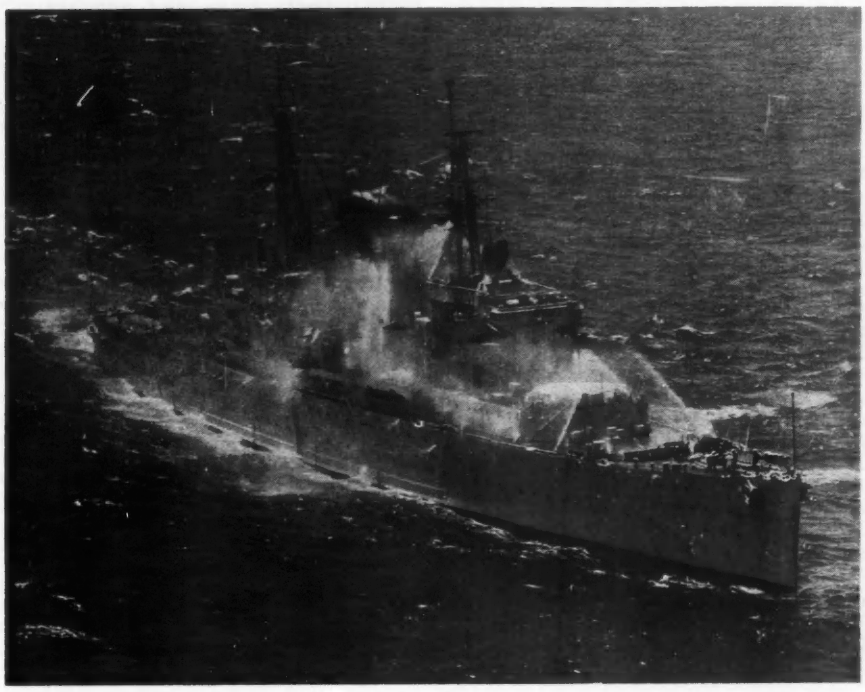
Research and Development

Following the introduction of the steam catapult and angled deck, the performance of carriers has been further improved by another British innovation—a robot signalling system to supersede the signal officer for aircraft landings on the decks of carriers. With the faster naval aircraft now coming into the Service, the time is too short for the human reactions between the signals officer and the pilot of the approaching aeroplane. The new device incorporates a large curved mirror on a gyro-operated mounting which keeps it at an angle constant to the line between the ship and the horizon. On each side of the mirror are two lines of coloured lights. A spot of light from the after part of the carrier is projected into the mirror. As the pilot approaches from astern he knows his angle of approach in the vertical plane is correct if he keeps the spot of light in line with the coloured lights. The curvature of the mirror makes the spot of light visible at all angles in the horizontal plane and the pilot has thus only to pick up the lights as he sweeps round to approach the carrier's stern. On the windscreen of the aircraft is fitted a translucent panel in which are reflected coloured lights situated alongside the air speed indicator. By watching the reflection of the lights the pilot is able to check his speed of approach.

When presenting the Navy Estimates the First Lord announced the development of a new radar-controlled 6in gun with a rate of fire three times that of any 6in gun now in service. In this connection it is not the number of guns carried, but the rate of shell output in a given time which is the true basis of a ship's fire power. Four of these guns are to be installed in each of the three still uncompleted "Tiger" class cruisers, and this should leave ample accommodation for guided missile launching platforms. Two submarines with a new type of propulsive machinery using hydrogen peroxide as oxydant for fuel are about to do their sea trials. They are capable of maintaining a speed submerged of well over 20 knots. A new and improved midget submarine, some 54ft in length, with normal diesel and electric propulsion is now in service for training and trials purposes and more of this kind are under construction. Research during and since the war has proved that when escaping from submarines a "free ascent" is preferable, as there is a likelihood of oxygen poisoning when breathing pure oxygen from the Davis submarine escape apparatus. To reduce the dangers of breathing air under pressure when flooding up a compartment to escape—poisoning from CO_2, which accumulates after some hours' diving, and "bends" (diver's paralysis) from the 79 per cent of nitrogen in the air—existing submarines will be fitted with bottles at each end of the vessel containing a mixture of oxygen and hydrogen and with a tube and mouthpiece for each man to breathe while flooding up. All these dangers will be largely obviated in new submarines in which space will be found for a one-man escape chamber, with its hatches and valves worked from the compartment. This will enable the crew to breathe air at atmospheric pressure until each man's turn comes to enter the one-man escape chamber. In less than a minute the chamber will be flooded and the man will have reached the surface. New submarines are also to have bulkheads strong enough to withstand the pressure at the depth to which the submarine can dive and the hatch of the one-man escape chamber will be fitted to take a rescue (diving) bell lowered down from a rescue vessel, thus making escape possible at depths of over 300ft.

A veil of secrecy still surrounds the production of guided missiles in this country, but there are now at least six guided missiles in quantity production in the United States. Of these, three are anti-aircraft missiles—the "Nike," a ground-to-air missile, 20ft by 1ft, with a range of 30 miles—is to be used for the defence of the major industrial areas; the "Sparrow" and "Falcon," air-to-air missiles with a range of 5 miles for use in U.S. Naval and Air Force fighters respectively. Offensive guided missiles are the "Corporal," a 5½-ton rocket credited with a range of 60 to 100 miles, for Army use; the "Matador," a pilotless bomber with a range of about 300 miles for launching from aircraft; and the "Regulus," a pilotless bomber of a similar type for launching from surface ships and submarines. Whether the guided rocket will become the main armament of warships will depend to a great extent on whether they are to have nuclear warheads. With conventional explosives the rocket would have little effect against armour. But with an atomic warhead a much smaller rocket than the "Corporal" would have all the necessary destructive power, though the reduced amount of fuel carried in the smaller rocket would reduce the range. It would seem, indeed, that the size of the rocket with an atomic warhead will determine the range at which actions would be fought and that a new type of battleship, with an armoured and closed-in upper deck, will be required as the future capital ship.

The Admiralty has been giving much thought to the decentralisation of port facilities in view of the vulnerability of our main ports to atomic attack. Some practical work has been carried out based on a detailed survey of our small ports, anchorages and beaches, and some improvements have already been made to such facilities and communications as already exist. Emergency plans for the discharge of cargo into lighters have been drawn up, for landing both at the smaller ports and on open beaches. This latter technique is more difficult in view of the need for costly amphibious craft to carry loads from the sea and over the beaches into the transhipment areas. The alternative of discharging into lighters would require many more lighters than are at present available for serving the existing major ports. A method of protecting warships against radioactive particles while operating in the "fall out" area, the outer fringe of the region affected by an underwater atomic bomb explosion, has been the subject of trials in H.M.S. "Cumberland," the trials cruiser. It is known as "pre-wetting" and involves the continual washing of all weather surfaces of the ship during and after exposure to contamination. Experiments have proved that radio active matter is less likely to adhere to a surface while it is being subjected to a system of salt water washdown, and such as does adhere can be removed more speedily from the infected parts. During the process all openings giving access to the interior of the ship are closed, and would remain so and the washing down would continue until ratings with geiger counters had ascertained that existing conditions on the upper deck allowed normal work to be resumed there.



H.M.S. "Cumberland" during trials of the "pre-wetting" system, by which warships can be protected against radioactive particles. Hundreds of tons of water an hour were pumped over the ship during tests in the Mediterranean

Dockyards and Maintenance

The current year's Navy Estimates provide for a net expenditure of £367 million, which includes £14,000,000 of mutual defence aid from the United States. The corresponding figures for 1953–54 were £364½ million and £35,000,000, the total being thus £2,500,000 less than for the current year. Much of the new construction under the rearmament programme is being carried out under contract, but the Royal Dockyards are doing the bulk of the modernisation and conversion programme in addition to normal repairs and

refits. Work has also now been started on the modernisation of dockyard plant and equipment and, for the first time in the history of the Royal Navy, married quarters are being built at the home ports for naval personnel. Since 1946, when Parliament passed a Bill authorising the fighting services to borrow money for the construction of married quarters, over 2000 houses have been built at isolated naval stations in the United Kingdom and at naval bases overseas. Further borrowing for house building was approved last year and the Royal Navy is now to get another 4300 houses or flats, 3800 of which are to be built at Portsmouth, Plymouth, Chatham and Lee-on-Solent. The modernisation of the Royal Naval Barracks and improvements in training establishments and Royal Naval Barracks are also in hand, including the building of an accommodation block for the staff and officers under training at Manadon, which forms part of H.M.S. "Thunderer," the Royal Naval Engineering College.

The scheme introduced in 1952 of laying up ships of the Reserve Fleet in commercial harbours is proving very successful. Frigates, minesweepers and seaward defence vessels have already been berthed at West Hartlepool, thirty-two destroyers at Newcastle upon Tyne, and thirty-four minesweepers at Porchester. Other ships are at Cardiff and Greenock. Their maintenance is largely in the hands of civilian labour after the vessels have been dehumidified and other special arrangements have been made for their preservation. A large number of the new coastal minesweepers and other small craft forming part of the rearmament programme are being placed in reserve on completion. Before being laid up in commercial ports they go from the builders to H.M.S. "Diligence"—the new small ships' equipping and commissioning base at Hythe—where they are fitted with naval equipment and placed in a state of preservation. Two of the new coastal minesweepers have been allocated as seagoing tenders to the Royal Naval Volunteer Reserve and more will be detailed for this service as they become available. The London Division of the R.N.V.R. is also to have the "Discovery" as an additional drill ship, when she has been refitted and adapted for naval service. Good progress has been made in the building of Admiralty oilers. The last of the eight fleet attendant oil tankers of a new class was completed and the first three fast replenishment tankers were launched during the past year. The former are of 2000 deadweight tonnage with a moderate draught, the latter are 583ft in length and 17,700 tons deadweight. Speeds have not been revealed.

With the addition of H.M.S. "Vidal" the naval survey fleet now consists of seven frigates and a number of motor launches. The "Vidal," completed in March, is the first frigate since the war to be designed, instead of converted, for surveying duties and is equipped with a hangar and a helicopter flight deck. Powered with the new Admiralty standard range I diesel engines, the vessel is equipped to operate in all climates. The Royal Navy has three fine feats of salvage work to its credit during the past year: the location and recovery of the widely distributed pieces of wreckage of the "Comet" from depths up to 600ft, in the Mediterranean; the location and recovery of a naval "Sea Hawk" in a strong tideway off the mouth of the Humber; and the salvaging of a French destroyer sunk in the Clyde fourteen years ago, which required one of the heaviest tidal lifts in the history of salvage operations.

Personnel

Recruiting and Re-Engagements.—For various reasons the Royal Navy is now very short of petty officers and skilled ratings; 8000 Special Service ratings (seven years' active, five years' reserve), who joined shortly after the war, are due for transfer to the Royal Fleet Reserve and all the retained men and reservists called up for the Korean emergency have now been released. Moreover, re-engagements for pension are still well below the normal in a number of branches and at the present time only a third of our Regular ratings are over twenty-five years old. There has also been a sharp fall in recruiting for the seamen and stoker branches and the Royal Marines, and the current estimates show a reduction of several hundreds on the personnel strength of 139,000 borne at April, 1954. Some 6500 national service men are being accepted this year as a temporary expedient to make good the shortage in Regular recruits. In the hope of improving recruiting and re-engagements in all three Services, the Government has approved further increases in pay—additional to the 1950 increases—to certain officers and selected men based on long service, skill and experience, and the tax-free £100 re-engagement bonus is to continue. Discharge by purchase for men and permission to retire for officers have been reintroduced subject to Admiralty discretion and depending on requirements in each rank or rate.

Reduction of Foreign Service.—As a further measure to encourage re-engagements, absence from the United Kingdom is in future to be restricted to a maximum period of one year except when on foreign service afloat in the Far East, Persian Gulf and in surveying ships abroad and on foreign service ashore. Foreign Service will in these cases be limited to eighteen months unless married officers and men serving ashore have their families with them, when they may be required to serve overseas for periods of up to thirty months.

Cadet Entry.—Increased importance is to be given to Dartmouth College as the result of the new system of cadet entry into the Royal Navy in one age group at about eighteen years of age. Cadets joining the Navy from May, 1955, onwards will receive an all-through course of training centred at Dartmouth, partly on shore and partly afloat. Thus, the whole of this early training, lasting about two years, will be conducted by a single authority at Dartmouth. Cadets on leaving the College will go to sea with the Fleet as acting sub-lieutenants for about eighteen months to complete their training. It has not yet been decided whether there should be one single entry of cadets with appointments to branches later, but meanwhile they will be entered as hitherto—as executive, engineer and supply and secretariat cadets—training for all three branches being carried out at Dartmouth. Electrical branch cadets will likewise do their early training there before going on to a university course and works training. A scholarship scheme is being instituted for sixteen-year-old candidates to enable lads to continue at school until old enough to compete for the Dartmouth entry. The new scheme thus does away with midshipmen afloat, gunrooms, seagoing training ships, and with all courses for acting sub-lieutenants at Greenwich and specialist schools.

Pensions for Officers.—The continued pressure in Parliament was eventually successful in inducing the Government to reverse its previous decision and to restore the 9½ per cent on the 1919 pension scale for officers, which, with a view to stabilisation, had been cut from the pensions of all officers retired between 1935 and 1945. The vast majority of these officers, however, who served in the war, and who were given in 1947 an increment for war service, have gained little from the concession, as they have concurrently had a substantial amount deducted from their increment given for war service.

Reserves.—The release of called-up reservists and the transfer of 8000 Special Service ratings to the Reserve will bring the strength of the Royal Fleet Reserve—all fully trained ratings—to about 22,500 during the current year—only 2500 short of establishment. The Royal Naval Reserve (recruited from the merchant navy and the fishing fleets) is expected to number about 4400 officers and men by April, 1955. The general service branch of this Reserve is up to strength, but officers and engine-room ratings for its patrol service branch are still not coming forward in sufficient numbers. An air branch of the R.N.R. has now been formed from volunteers who are ex-pilots employed by firms engaged in Admiralty contracts. Steady progress continues to be made in recruiting for the Royal Naval Volunteer Reserve and the Royal Marine Volunteer Reserve (both recruited from civilians) and their strength this year is expected to reach 13,000 and 1700 officers and men respectively. Yet another reserve force is the Royal Naval Special Reserve (for national service men doing part-time training), whose strength this year should be about 11,500. In June, the R.N. Volunteer Reserve celebrated its fiftieth anniversary (a year late because of the Coronation) with a review by H.M. The Queen of some 2000 officers and men from the twelve general service and five air divisions. The review included a fly past of nearly 100 aircraft from the twelve R.N.V.R. air squadrons.

Exercises and Operations

Wherever ships of the Royal Navy are stationed, every opportunity has been taken during the year to carry out combined exercises with the navies of the Dominions and the N.A.T.O. powers. About twenty combined exercises have been held each year by two or more of the N.A.T.O. navies since that organisation was formed in 1949, most of them unspectacular but all organised with the primary object of enabling an international air-sea force to work as a team in safeguarding the allies' vital sea communications. Great progress has already been made in overcoming language difficulties, difference in naval practice and procedure and the lack of a unified signalling system. During 1954 the two outstanding exercises in Home waters were "Haul"—an air-sea exercise in the Channel area to test the defence of shipping against air attack, in which about 100 small warships and also aircraft from Belgium, France, the Netherlands, Norway, the United States and Britain took part—and "Morning Mist." The latter, involving the movement of troops, was conducted by the three main N.A.T.O. commands covering the Atlantic, the Channel area and the mainland of Western Europe. In the Central and Eastern Mediterranean, exercise "Medflex Baker"—in which ships and aircraft of France, Greece, Italy, Turkey, the United States and Britain took part—provided the maximum opportunities for commanders ashore and afloat.

Labour in 1954

By GERTRUDE WILLIAMS

No. II—(*Concluded from page 6, January 7th*)

The "Just Price" of Labour

THE Ministry of Labour's courts of inquiry into the shipbuilding and engineering industries' wage claims followed the usual line—recommending a rise, though a good deal less than had been asked for. But on what was the amount based? It bore no relation to the rise in the cost of living, and, indeed, there is no reason why it should have done. It also bore no relation to the rise in productivity, for this has been in the region of 2½ per cent annually since the end of the war and not the 5 per cent proposed by the Courts. Why, then, choose this particular figure?

The Courts themselves were evidently bothered by this question and it is presumably because of their inability to find an answer that at the end of their reports they broke new ground. "During this inquiry," they stated, "it has been borne in upon us that some of the issues that have been raised are essentially part of much wider problems affecting the national economy. . . . But we do not feel able to assess or quantify the dangers to the national economy which might arise from action which provoked a general and substantial increase in production costs, e.g. whether even a slight upward thrust in the inflationary spiral would be disastrous or whether any increase in export prices would, under present circumstances, really undermine the country's capacity to pay for the imports we need." They suggested, therefore, the setting up of an authoritative and impartial body to consider the conflicting arguments on these issues and to give advice and guidance on broad policy and possible action.

Easier said than done. This continually recurring proposal for an authoritative and impartial body to guide wages movements seems to be the twentieth century manifestation of the mediæval belief in the "just price." It stems from the optimistic, but blind, belief that there really must be a "right" wage if only one could find it. But it cannot be too often repeated that this is an illusion. Justice must take a hand in wage negotiations in order to ensure that no group is able to exploit the weakness of another and to lay down the minimum standards that are culturally acceptable to the community. But apart from establishing, so to speak, the environmental circumstances within which bargaining takes place, how is it possible for any body, however "authoritative and impartial," to decide what a wage "ought" to be. The stream of goods and services that constitutes the national income is the result of the co-ordinated activities of 23,000,000 people and who is to say how much has been contributed by any individual or group, or what would be the repercussions of an arbitrary change in the share meted out to any of them? Wages are a price of something that is negotiable—human services of different types and intensity—and the decision how much these services are worth to either buyer or seller is not something that can be laid down by an external authority unless that authority also lays down in precise detail what is to be produced, how and by whom.

Our valuable and intricate system of machinery for the prevention and settlement of disputes is not intended to find a "moral" basis for wages and it would fail disastrously if it tried to do this. What it really does—and on the whole fairly successfully—is to try to discover, by taking into account the economic situation and the position of the disputants, what would probably be the result if the quarrel were allowed to go to the extreme of a strike; and then to get agreement without the suffering and waste of a strike. What it can also do, and this, too, has great constructive value, is to suggest for consideration, factors and modifications that might not be given full weight when feelings on both sides have become exacerbated by reciprocal hostilities.

Ship Repairers' Strike

But the principal industrial disputes this year have been due primarily to other things than wage demands. Ship repairers in London came out on strike on the question of the order of dismissal during a period of labour redundancy and insisted that "Last in, first out" should be the rule. The busmen based on the majority of the London garages banned overtime in order to call attention to the shortage of staff. They argued that it was hopeless to expect new recruits as long as the wages in this section of transport remained so far below the average earnings in other occupations (a very strong argument in this case) and that unless more men were attracted, busmen would continue to be overworked. In order to relieve the pressure on the routes most affected by the ban, London Transport diverted certain buses, with the result that the men from about 20 per cent of the garages came out on strike, against the advice of their union, the Transport and General Workers' Union.

The Docks Strike

The strike in the docks, however, was more serious and more complicated than most others. Since the "decasualisation" of labour was introduced as a permanent peacetime scheme in 1947, work at the docks can be done only by registered dockers employed by registered employers. The wages are fixed as usual by collective bargaining and a man receives the amount he earns at this rate. But in case he does not get employed for every shift, because of movements of tides, or fog, or alterations in the quantity of shipping, he gets a guaranteed weekly wage as a minimum. Part of the dock workers' scheme through which this weekly wage is ensured provides that the worker shall work when he is required, "if it is reasonable in his case to do so." This has always been interpreted to mean that the obligation to work overtime is compulsory in a general sense, but that the individual might be excused if he had personal or domestic reasons to justify his unwillingness or if he could find a substitute. It is not suggested that there has been any harshness in the administration of this rule, nor has it led to excessive hours of work. An analysis of the average hours worked during a six months period showed 33·38 "normal hours" (i.e. between 8 a.m. and 5 p.m.), 5·16 hours when work was not available and attendance was proved (i.e. counted for the guaranteed wage), only 2·92 hours' overtime (i.e. after 5 p.m. and before 8 a.m.) and 1·28 hours' week-end work (which is voluntary). The most usual occasion when overtime is required is when a ship needs one or more hours to finish loading or unloading after 5 p.m. has struck.

The National Association of Stevedores and Dockers, however, insisted that overtime should be completely voluntary. They agreed that many men were perfectly willing to work overtime and that it was rare for a man to be compelled to stay on if he had given a reason for refusing; but they held to the point that any measure of compulsion in this respect was wrong in principle. In order to try and force the employers to agree with this reading of the situation, early in the year they banned overtime for their members altogether. The N.A.S.D., however, organises only a minority of dockers, most of whom are members of the Transport and General Workers' Union and as this union did not support this view of the overtime obligation, it continued to negotiate with employers in the usual way. The N.A.S.D., therefore, came out on strike and were joined by certain members of the T.G.W.U. in sympathy. For the N.A.S.D., then, this was an official strike; for the T.G.W.U. it was unofficial.

The issue was further complicated by the anger of the T.G.W.U. when its dissident members were received into the fold of the N.A.S.D. Poaching of members of one union by another during a trade dispute is expressly forbidden by the rules of the Trades Union Congress, and the T.U.C. went so far as to call upon the N.A.S.D. to desist from its action.

From the beginning the employers expressed themselves willing to discuss the phrasing of the overtime rule so as to make it clear that it would not impose undue hardship on any individual, provided the men would go back to work, but Mr. Barrett, the leader of the N.A.S.D., refused to budge. After a long and expensive stoppage men began to drift back to work and the N.A.S.D. found itself compelled to call off the strike on exactly the terms it could have got a month earlier.

The whole thing was a very sorry business and made even worse by the unfortunate personal rivalries of the leaders of the unions. There was a good deal of talk of Communist agitation and even if the Communists did not begin the bother, they were, as always, ready to take advantage of a bit of trouble. But the aspects that call for special comment are serious because they point to more fundamental problems, and reflect the difficulties in which trade unions find themselves in adjusting themselves to the changed world of to-day. The first of these is concerned with the uncertain role of the trade unions when sharing in the administration of a scheme of joint control.

The Dock Labour Scheme is administered by National and Port Boards representative of employers and workers—on the face of it an obvious and fair arrangement. But in practice it has not contributed to smooth working and may, in fact, be itself a cause of trouble. As wages are guaranteed by the Board (which collects the necessary funds by a levy on the employers' wages bills) it is simpler for dockers to claim the whole of their pay and not only their guaranteed money at the Board's offices. The effect of this is that the worker no longer knows who his employer really is—the Board from which he collects his money or the firm that seems to be employing him. Any sense of responsibility or loyalty is thus weakened. In any case, it is difficult for the docker who, because of the traditions of casual employment, has always regarded himself as his

own man with nobody but himself to consult if he decides to miss a shift, to recognise the obligation to work whenever and wherever called upon, which is the price he pays for the guaranteed weekly wage. If he absents himself without permission he may be hauled up before the disciplinary committee of the Board and find himself confronted by a group of men, half of whom are the officials of his own union. It is no matter for surprise if he is confused and wonders why he should pay union dues to support officials who, instead of standing up for him as they used to do, sit in judgment on him.

There is little doubt that this ambivalence in the position of the union official since the inception of the scheme has been a strong, though not necessarily overtly recognised, contributory factor in the series of dock disturbances throughout the last few years ; and it is a great pity that the Government turned down the proposal that a thorough investigation into the structure of the scheme should be undertaken.

Although the men have gone back to work the trouble is not over. Talks have been resumed and a number of points have been cleared up which should lessen the likelihood of disciplinary measures being necessary. But on the main issue the position is unchanged ; the T.G.W.U. is prepared to accept the employers' formula that, when all else fails, overtime must be regarded as an obligation, and the N.A.S.D. is not. Trouble during the next few weeks is unlikely because the men are anxious to work overtime to make up lost earnings to meet the Christmas expenses. But later on, when this is no longer a lure, employers will report men who have failed to give a reasonable excuse for not doing overtime and the whole argument will begin again.

The Mammoth General Union

The second feature illustrated by the dock strike is the problem of structure and control of the mammoth general union, characteristic of to-day.

During the last fifteen years the membership of trade unions has gone up from 6½ millions to 9½ millions and the number of unions has dropped from over 1000 to 687. Two-thirds of all trade unionists are now in only 2·4 per cent of all unions. The rapid development in the size of the principal unions which these figures indicate has thrown up all sorts of new problems of administration and policy control; the Transport and General Workers' Union, on account of the complexity of its structure as well as of its size, is an excellent example of the new development.

The oldest part of the T.G.W.U. is the Dockers' Union, founded nearly seventy years ago. Dockers were then casual labourers and there was no unemployment insurance ; so the lines of demarcation between dock work and general labouring in many industries were extremely blurred. It was therefore an obvious step for the union to expand to take in these related occupations. Later, largely by the efforts of Ernest Bevin, there was an attempt to bring together many miscellaneous unions serving different types of transport worker—carters, seamen, busmen, dockers, &c.—and finally he succeeded, forty years ago, in founding the T.G.W.U.

It was a wise move and gave protection to many occupations, none of which was strong enough to stand alone ; but it had its dangers and these have now come more into evidence. There is not the same identity of interest between many groups of workers, whose conditions of employment have little in common ; the members feel their group loyalty involved much more in the section to which they belong than in the union as a whole, and it is difficult, if not impossible, to get both a well-devised concerted national policy and a considerable degree of self-government for different interests.

The T.G.W.U. is not the only union to face these structural problems, but it has figured recently in so many disputes in which these internal troubles have been more serious than any wage demands on the employers that, as the *Economist* said : "To twist the tail of the T.G.W.U. is now almost a registered national sport."

Some people argue that the very size of such a union is a source of strength, not merely because of its funds, which obviously help it in collective bargaining, but because members are proud of its record, even in other occupations than their own, and identify themselves with its power and achievements. Others think exactly the opposite. Size leads to strength only when there are no conflicts of loyalty between the small group to which the individual unionist feels himself most closely allied and the large amalgamation of which the small group is only an insignificant part. The more heterogeneous the occupations joined together in the mammoth organisation, the more likely is the loyalty to the group to take precedence of loyalty to the national body, and even a theoretically perfect constitution is likely to break down over this.

It is size which leads also to a third problem which was demonstrated during the dock strike—a tendency to develop a somewhat authoritarian attitude towards the individual member. It is easy to see why a union should wish to be responsible for everybody in a particular occupation. It is a neat and tidy arrangement and makes the whole process of collective bargaining much less difficult. It has also, perhaps, a less estimable side, for it undoubtedly gives a great deal of power to the national officers and seems to lead to an inclination to look upon members as the property of the union which it is immoral for any other union to steal. But if a trade union wishes to keep its position as a voluntary association (and there is no doubt that this is passionately desired by practically everybody) it must face the fact that some people may prefer to belong to one organisation rather than another and that a break-away movement is not necessarily a sign of moral depravity. It may, indeed, be the only way in which a minority can express its disagreement with the policy and actions of the national executive, and the tradition of loyalty to the union is so strongly engrained in the British movement that a sensible union committee should look upon any marked tendency towards a transfer of membership as a danger signal that something in their own organisation needs careful scrutiny rather than as treachery that must be put down with a strong hand.

Unfortunately, this is only one example of the increase in intolerance. For three-quarters of a century most industrial disputes have included in their terms of agreement a clause stipulating that there should be no victimisation. Unions realised that it would be impossible for them to build up the strength they needed to protect working conditions if any person who was particularly active in the struggle had to face the likelihood of permanent unemployment as a marked man—an agitator whom no employer wanted in his works. But in many recent disputes, the man who has not seen eye to eye with the majority policy of the union has been the one to be victimised by the union itself and there have been two or three instances during the year of men who had refused to strike being heavily fined or, worse still, hounded from their work by their intolerant fellow unionists.

It is evident that there is much for the unions to overhaul. There is need to think out afresh the basic principles and to educate their members in the nature of voluntary association. No collective body can carry on its work unless the members abide loyally by the decisions of the majority ; but also no such body can continue to command the loyalty of its members unless it keeps a strict watch over any unnecessary encroachment into individual liberty.

During the recent war, everybody recognised the need for more strict control of the actions of the citizen than is normally acceptable. Many freedoms were willingly suspended until the emergency was over—though it is worth remembering that even during the war there was legal protection of the conscientious objector. Too many trade unions seem to retain the war mentality with regard to their own government. Though they are no longer fighting for their existence as they were a century ago, they are terrified of any deviation from the line the majority want to toe. But wealthy and powerful as they now are, they will not keep the moral force they had when they were only a quarter their present size, unless they take steps to curb their growing tendency to totalitarianism.

Pensions

Financial provision for older people has been one of the chief matters of concern during the year. This is due, in part, to sympathy with the difficulties of those with no other resources than their retirement pension during a time of rising prices and, in part, to the interest with which the report of the Phillips committee (the committee on the economic and financial problems of the provision for old age) has been awaited. The Government has announced its proposals for increasing the rates of pension and it is probable that by the time these words appear in print they will already be law. The general effect of the new rates is to restore the purchasing power of the pensions fixed by the original act in 1946 with a slight margin in hand to allow of a small continuing upward movement in prices ; and to restore also the relation of pensions as about one-third of the average of industrial earnings.

Although the Phillips report was not published before the Government made its announcement, the main findings were known to the Minister of National Insurance and so presumably they were taken into consideration. But it is a pity that time was not taken to allow of a full discussion of the implications before committing the country to an increase of expenditure on such a scale.

There is no question that older people with no other resources are inadequately provided for on the existing scales ; but it does not, therefore, immediately follow that the only or best way of remedying this situation is to raise the rates. The most important features of the rapidly changing age composition of the community are now beginning to be well known. As a result of lower birth-rates and lower death-rates, the proportion of older persons in the community is growing bigger, for those who were born sixty to eighty years ago, when birth-rates were high, enjoy the present longer expectation of life and are still with

us, whilst the lower birth-rates of this century have reduced the numbers entering the working ages.

It is estimated that during the next twenty-five years the insured population will remain roughly constant at about 23,500,000 to 24,000,000, whilst in the same period the number of pensioners will rise from 4⅛ million to over 7,500,000. At present for every person receiving a pension there are about five contributors; in ten years' time the ratio will be 1 to 4 and by 1979 it will be 1 to 3. Retirement pensions cost £350 million a year at present; even at the present rates they would cost £490 million in ten years' time and £665 million by 1979. At the new rates the Government Actuary estimates an expenditure of £592 million in ten years' time and of £798 million in 1979.

The expenditure of such a colossal sum makes it essential to ask whether we are getting value for money. That older members of the community should be able to depend on receiving a reasonable subsistence and that it should be provided in a dignified manner which helps to preserve the self respect of the recipient is no longer, fortunately, a matter on which there is any difference of opinion. There can be no turning back to the old Poor Law methods with the physical and psychological suffering that they entailed. But the whole situation is now totally changed. Not only have earnings been both higher and more regular over a considerable period but—very much more important—there has been a remarkable development of voluntary superannuation schemes, associated with different kinds of occupation. It is difficult to get accurate figures of these but the Phillips committee estimated that well over 8,000,000 people are covered by such schemes—as compared with 1,500,000 in 1936. This is an extraordinary change to have taken place in less than twenty years.

When the Beveridge report—on which the National Insurance Act was based—was published in 1942 this development had not taken place and Beveridge was right to insist on the importance of ensuring that every citizen should be able to look forward with equanimity to an old age free from carking poverty. At that time this could not have been achieved without a retirement pension on an adequate subsistence level guaranteed as a statutory right without consideration of the private means of the individual.

And even though the situation has undergone so radical a change there is still something very attractive in a statutory provision which is available to all citizens, irrespective of their particular situation, as a civic right. But a very great deal of money is involved and funds spent on one purpose inevitably involve cutting down on something else. The question now is, therefore, what is the best way of spending the money? Will it add more to welfare and happiness if it is spread evenly over the whole community, so that the retired managing director benefits as much as the retired dustman, or will it do more good if the available resources are concentrated where need is greatest. At present about one quarter of the people in receipt of retirement pensions get supplementary amounts from the National Assistance Board. They are mostly old people living alone or two pensioners living together. To leave the pensions as they are would free considerable sums for a comfortable provision for these. This is the choice that will be one of the serious issues of 1955.

Shipbuilding and Marine Engineering in 1954

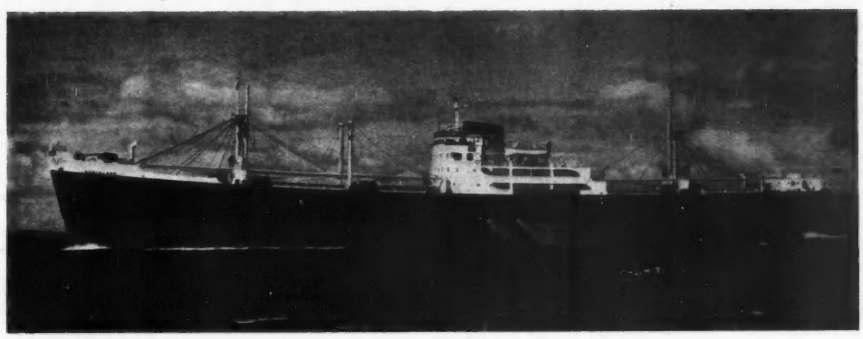
No. II—(*Continued from page 18, January 7th*)

CARGO-PASSENGER AND CARGO SHIPS

SEVERAL of the liners completed during 1954 are illustrated in Plate 4 and some of the cargo-passenger ships are shown in Plates 5 and 6. Among the other cargo-passenger ships completed was the "Bow Santos," built by Hall Russell and Co., Ltd., for Norwegian owners. This is a single screw shelter deck ship of 8010 tons deadweight on 25ft 1in summer draught and the main dimensions are as follows: length overall 425ft, length between perpendiculars 395ft, breadth moulded 58ft, and depth moulded to shelter deck 37ft 4in. The cargo is carried in five holds and a deep tank and the derrick complement includes one to lift 25 tons, and three 150kW diesel-driven generating sets supply the power for the engine-room auxiliaries and deck machinery. A five-cylinder Wilton-Fijenoord-Doxford oil engine of 5500 b.h.p. at 112 r.p.m. provides the necessary propelling power. Another ship for Norwegian owners was the "Staholm," which has holds equipped for bulk cargoes of grain or cotton and deep tanks for the carriage of vegetable oils and was built by Swan, Hunter and Wigham Richardson, Ltd. The ship has a length between perpendiculars of 430ft by 60ft 6in breadth moulded by 38ft 9in depth moulded to the upper deck and carries four passengers and a deadweight of 9000 tons on a draught of 25ft 6in. A derrick of 25 tons capacity is included in the normal complement of 3-ton and 5-ton derricks and the holds have a bale capacity of 504,756 cubic feet. MacGregor's steel hatch covers are fitted and power for the electric winches, ship's services and auxiliary machinery is provided by three 175kW diesel-driven generators. A service speed of 14½ knots is maintained by a Wallsend-Doxford opposed piston, two-stroke, oil engine having five cylinders of 670mm diameter by 2320mm combined stroke and developing 5000 b.h.p. at 108 r.p.m.

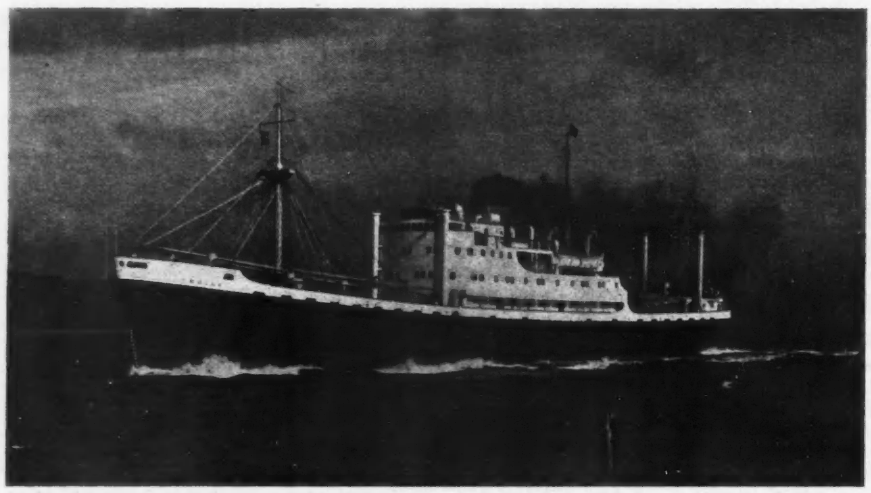
For the South and East African service of the Union-Castle Mail Steamship Company, Ltd., Harland and Wolff, Ltd., built the "Tantallon Castle" and a sister ship, the "Tintagel Castle." Both ships provide accommodation for twelve passengers and have a length overall of 493ft, a length between perpendiculars of 465ft, a breadth moulded of 65ft 6in, a depth moulded to the shelter deck of 41ft 6in, and a gross tonnage of about 7450. The cargo, which is carried in five main holds, is handled by eight 5-ton, eight 10-ton, two 30-ton and one 80-ton derricks operated by electric winches. The electrical installation consists of three 250kW diesel-driven generators and each ship is propelled by a double-acting, two-cycle oil engine, arranged to burn heavy grade oil fuel, having eight cylinders of 620mm bore by 1400mm stroke.

Three of the cargo ships completed during last year were shown in Plate 8, which appeared in our issue of last week. Also handed over during the year was the S.S. "Nuddea," which completed successful trials in August, and is the first of a series of large cargo liners for the owners' special services. Barclay Curle and Co., Ltd., built the ship to the order of the British India Steam Navigation Company, Ltd., and the main particulars are: length 514ft, breadth 67ft, depth to shelter deck 42ft, and gross tonnage 10,130. Of open shelter deck design with forecastle, the ship has six cargo holds with associated 'tween decks, including some fitted to take refrigerated cargo, served by twenty derricks of 6 tons and 10 tons capacity and two heavy derricks capable of lifting 50 tons and 25 tons, respectively. A service speed of 16½ knots is maintained by a set of three casing turbines, of Parsons design, geared to give the propeller a speed of 116 r.p.m. Two water wall, marine water-tube boilers, burning oil fuel under the closed duct system of closed draught, provide steam at 475 lb per square inch and 750 deg. Fah., while the electrical requirements of the ship are met by four 300kW diesel-driven generators.



Motor cargo ship "Huntsland"

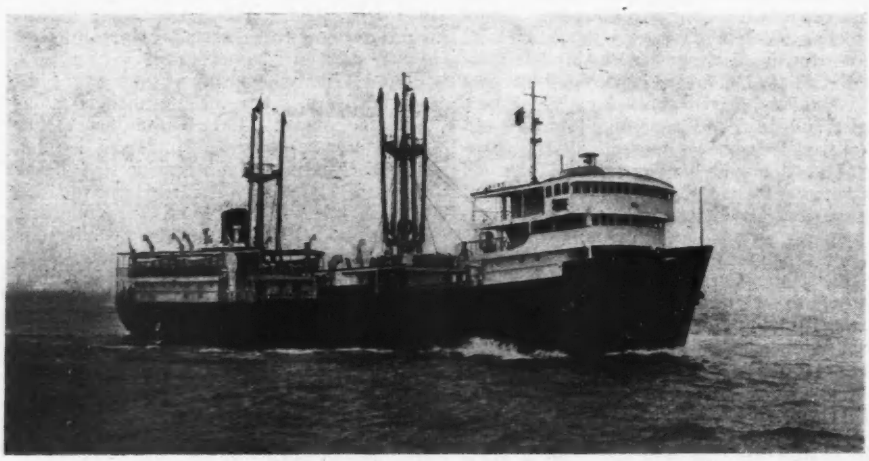
The Power Steamship Company, Ltd., took delivery, from the Burntisland Shipbuilding Company, Ltd., of the open shelter deck motor cargo ship "Huntsland," which can be seen in our illustration. A deadweight of 11,750 tons is carried on a loaded draught of 27ft 1½in, and the following dimensions: length between perpendiculars 450ft, breadth 64ft, and depth moulded to shelter deck 40ft 5in. Derricks including six 5-ton, four 10-ton, one 40-ton and one to lift 50 tons handle the cargo, which is carried in five holds, one of which is arranged as a deep tank. Propulsion is by a six-cylinder Hawthorn-Doxford oil engine of 6600 b.h.p., and having cylinder dimensions of 670mm diameter by 2320mm combined stroke and arranged to burn fuel oil, and installed by the shipbuilders. During the year Smith's



Single-screw steamship "Rollo"

Dock Company, Ltd., completed the S.S. "Romanic," which is the second of four vessels ordered by the Bolton Steam Shipping Company, Ltd. The ship, of open shelter deck design, has been built on the longitudinal system having longitudinal framing for the bottom shell, tank top, second and upper decks, transverse side framing, and corrugated main bulkheads. A trial speed of 13½ knots was attained with the ship in ballast condition and the ship has a deadweight carrying capacity of 9927 tons, the draught being 26ft 2½in. There are five cargo holds and a similar number of 'tween deck spaces and the following are the principal dimensions: length overall 450ft 8in, length between perpendiculars 426ft, breadth moulded 59ft, and depth moulded to upper deck 38ft 3in. Each hold is served by two 5-ton derricks operated by steam winches and three 40kW steam-driven generators supply the electrical power for the ship's services. For propelling the ship there is a triple expansion engine, having cylinders of 24½in, 40in and 68in diameter by 45in stroke, working in conjunction with a Bauer-Wach turbine to develop a total of 3000 i.h.p. at 85 r.p.m. Three single-ended, multi-tubular, oil-fired boilers supply steam at 220 lb per square inch and 580 deg. Fah.

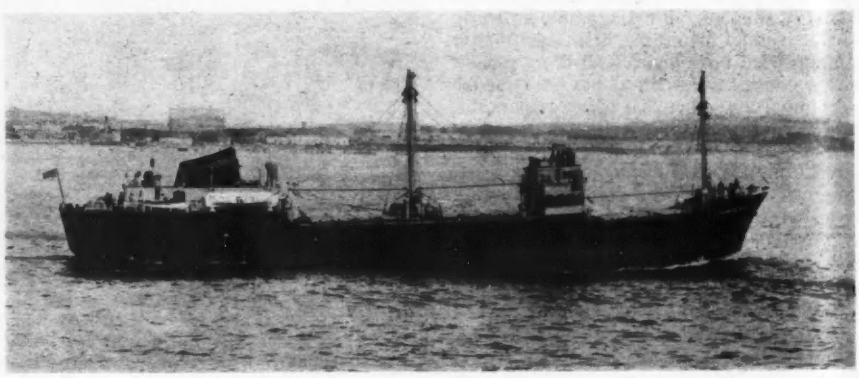
Among the smaller cargo ships completed was the open shelter deck motor vessel "Dundee," which has the propelling machinery arranged aft and has been designed and equipped for canal navigation and general cargo trading in the Saint Lawrence River and the Great Lakes of Canada. The ship, built by the Burntisland Shipbuilding Company, Ltd., for the Dundee, Perth and London Shipping Company, Ltd., has a length between perpendiculars of 251ft, a breadth moulded of 43ft, a depth moulded to the shelter deck of 29ft 2in, a draught loaded of 18ft 11in, and a gross tonnage of 1781.



Twin-screw motorship "Auby"

Ferries and Short Sea Traders

During the year, Ellerman's Wilson Line, Ltd., took delivery of the S.S. "Cicero" and a sister ship, the S.S. "Rollo," seen in our illustration, from Henry Robb, Ltd., both ships being designed for service in the owners' Mediterranean and Scandinavian trade. The ships, of open shelter deck design, have the following particulars:—Length overall, 309ft 6in; length between perpendiculars, 290ft; breadth moulded 48ft 6in; depth moulded to upper deck, 27ft; draught loaded, 17ft 9½in; deadweight, 2520 tons, and gross tonnage, 2497 tons. Single and double-berth cabins are provided for twelve passengers, and the cargo is carried in four holds, one of which is insulated, and three 'tween decks having a bale capacity of 158,360 cubic feet. For handling the cargo there are four 10-ton and six 5-ton derricks operated by steam winches, while two 60kW and one 30kW steam-driven generating sets provide electrical power for the ship's services. A service speed of 13 knots is maintained by a triple-expansion reciprocating engine supplied by Swan, Hunter and Wigham Richardson, Ltd., having cylinders of 20in, 34in and 54in diameter by 56in stroke, working in conjunction with a Bauer-Wach exhaust steam turbine and single helical reduction gearing built by Barclay Curle and Co., Ltd. Two cylindrical, oil-fired, multitubular boilers, working under Howden's forced draught system, supply steam at 225 lb per square inch and 180 deg. Fah.

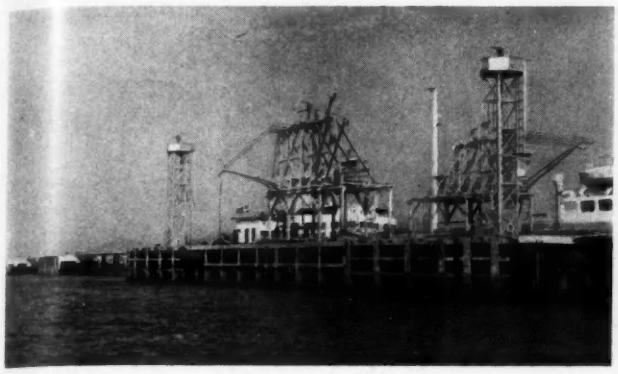


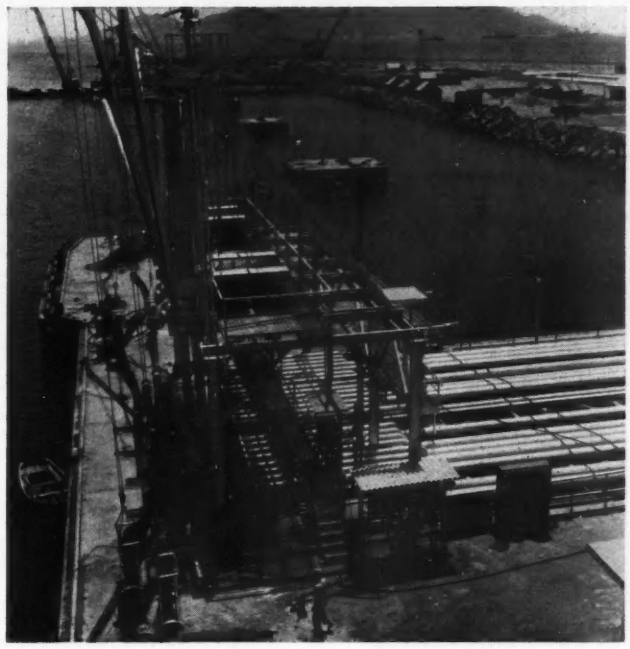
Raised quarter deck motorship "Rambler Rose"

Another ship built by Henry Robb, Ltd., was the closed shelter deck, twin-screw passenger and cargo motorship, "Auby," illustrated on this page, for the Sarawak Steamship Company, Ltd. A deadweight of 1170 tons is carried on a mean draught of 11ft 9in and the the following dimensions: Length between perpendiculars, 212ft; breadth moulded, 44ft, and depth moulded to upper deck 21ft. There are two holds and associated 'tween decks, with a total bale capacity of 91,000 cubic feet, served by two 10-ton and four 3-ton derricks and electrical winches. Power for the deck machinery and auxiliaries is provided by three 75kW generators, each driven at 600 r.p.m. by a 136 b.h.p. diesel engine, while there is a 15kW diesel-driven generator for emergencies. The ship is driven at a service speed of 10 knots by two seven-cylinder, four-stroke, supercharged, non-reversing Ruston and Hornsby diesel engines, which develop a total of 1060 s.h.p. at 500 r.p.m., and are directly coupled to the propeller shafting through Modern Wheel Drive S.L.M. oil-operated reverse reduction gears, which give the propeller a speed of 250 r.p.m.

Hall, Russell and Co., Ltd., completed two open shelter deck motor vessels, the "Whitby Abbey" and "Fountains Abbey" for the

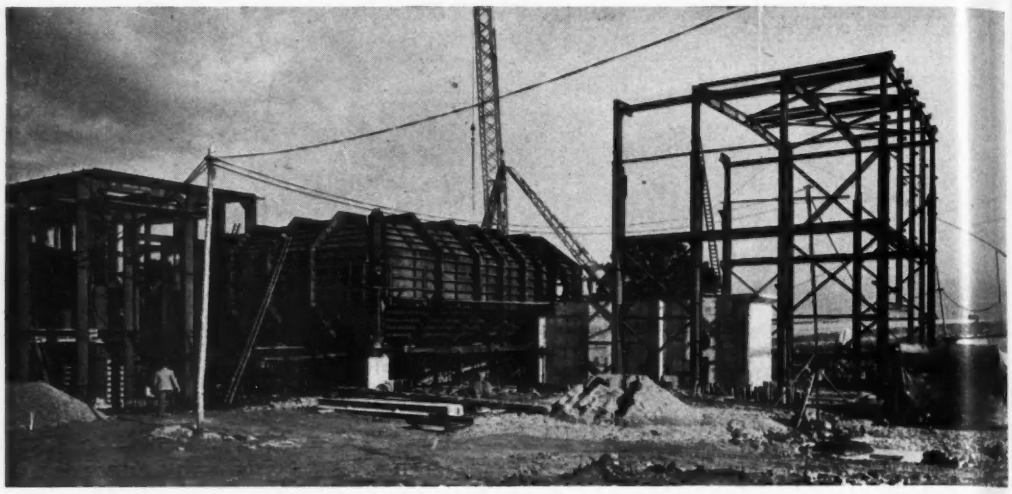
ADEN OIL HARBOUR





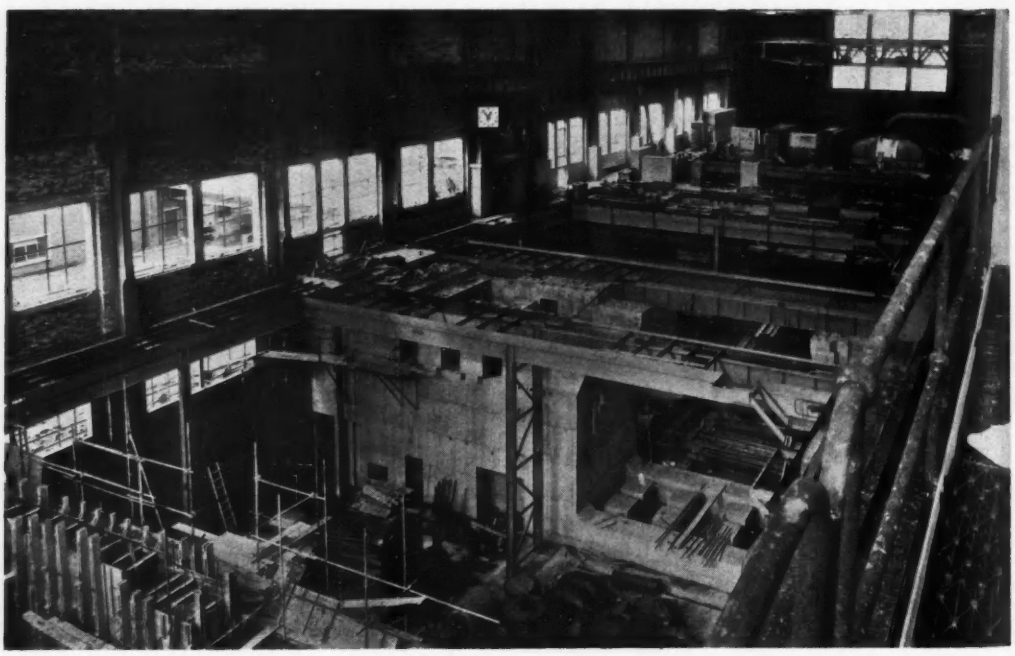
Construction of the new refinery and associated oil harbour at Aden for the British Petroleum Company was started at the end of 1952 and finished last October. The harbour was designed for tankers up to 32,000 tons deadweight and is dredged to 40ft at low water. There is an approach channel 600ft wide, 1½ miles long, and having 38ft at low water, the dredging totalling some 6,000,000 cubic yards. A rubble breakwater 4300ft long, constructed of rock graded up to 11 tons in weight and surmounted by a concrete parapet was built. The interior of the harbour was developed by building rubble mounds and then pumping ashore the dredged spoil to form 240 acres of reclaimed land upon which the tank farm, access roads and port buildings stand. Oil is handled at four tanker berths at two "T" head jetties and one double-sided "finger" jetty. Each jetty consists of an all-welded steel framework supported on steel box piles with a light reinforced concrete deck. Berthing shocks are absorbed in a flexible fendering system which incorporates large rubber blocks mounted on the steel frame, the horizontal forces being dispersed through the frame to raking piles. Four ancillary jetties were constructed for harbour craft. The finger jetty head is 250ft long and 120ft wide, with oil handling facilities on each face. It is approached by a 700ft long road and pipeway supporting two layers of pipes. The "T" head jetties were constructed along the south side of the dredged basin 900ft apart. The approaches to these jetties are 175ft long and the jetty heads are 250ft long. A line of nine mooring dolphins was constructed 100ft back from the berthing line to serve both jetties. Consultants: Rendel, Palmer and Tritton; contractors: harbour, George Wimpey and Co., Ltd.; dredging, Dredging and Construction Company, Ltd., and K. L. Kalis Sons and Co., Ltd.

STRUCTURAL ENGINEERING IN 1954



The Aircraft Research Association's transonic wind tunnel has a nominal cross section of 9ft by 8ft at the working section. About one and a half tons of air is circulated per second. It is a welded steel structure, with two 90 deg. bends downstream from the working section, one of which is shown here. The steelwork is designed for a static pressure differential of ± 3 lb per square inch, and a temperature differential of 90 deg. Fah ; anchor points are provided to control the longitudinal and lateral temperature movements. Structural consultant : W. A. Mitchell; Contractors: Moreland Hayne and Co., Ltd.; G. A. Harvey and Co. (London), Ltd.

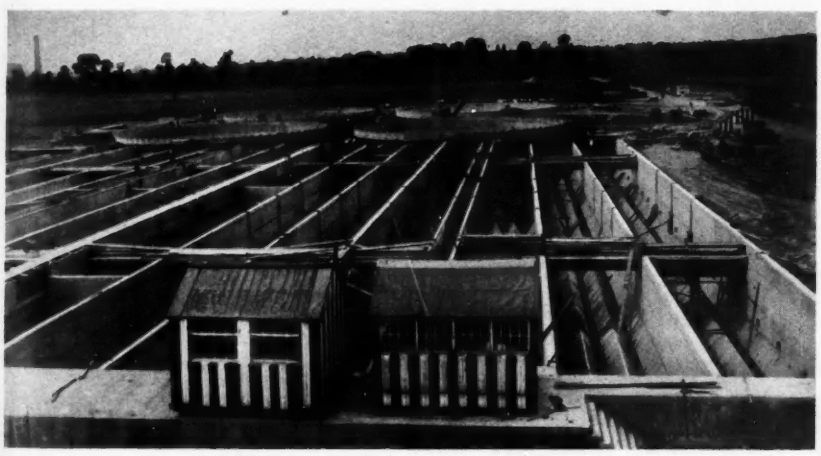
The main production hall of the Bank of England's new printing works at Debden. The asymmetrical shape of the arches and the frequent cross barriers give the best interior illumination. The arches span 125ft and are prestressed. A complete bay, 36ft in length, and comprising an arch rib at each end and the shell roofs between, was erected from one setting of a travelling erection gantry. The arch ribs were precast in sections and the shell roofs poured *in situ*. Consultants : Ove Arup and Partners ; contractor : Sir Robert McAlpine and Sons, Ltd.



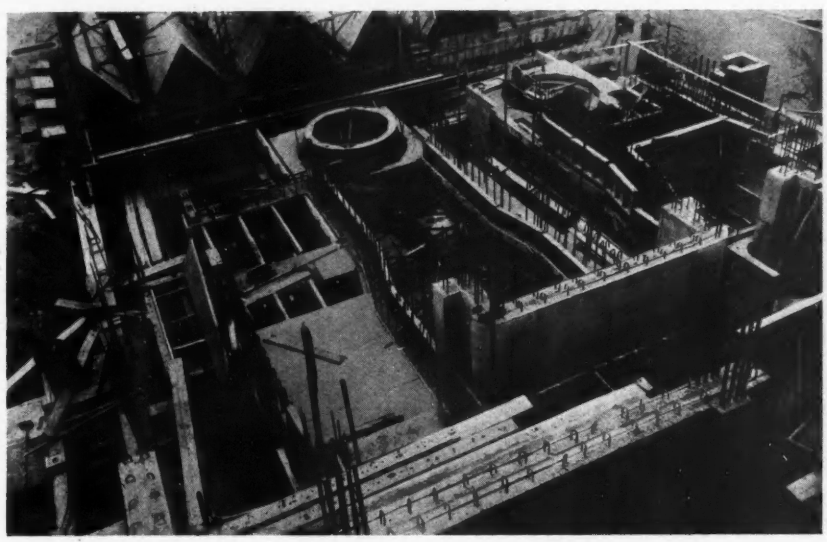
The B.E.A. power station at Ince, 6 miles north of Chester, will consist of four 60MW turbo - alternators with unit slung boilers. The station is semi-outdoor ; a boiler-house is not provided but the drum and operating floors of the boilers are enclosed by sheeting. The main buildings are sited on hard - bound sand. The coal sidings are situated on the reclaimed marsh to the east and the four natural draft cooling towers to the north are on piled foundations driven through the peat into the clay overlying the dipping hard - bound sand stratum. Construction started in May, 1951, and two sets were to be commissioned by the end of 1954. The illustration shows a turbo-alternator foundation block in the foreground. Plant design : North West Merseyside and North Wales Division, B.E.A. ; civil engineering consultants, Rendel, Palmer and Tritton

RYE MEADS SEWAGE DISPOSAL WORKS

The Middle Lee main drainage scheme provides trunk sewers in the Lee Valley to serve the new towns of Harlow, Stevenage and Welwyn-Hatfield, and a purification works at Rye Meads, illustrated here. The first stage of the scheme is expected to be in operation towards the end of this year. The population served will be 160,000 in stage 1 and 320,000 in stage 2, the designed sewer capacity being 300 gallons per day per head. It is hoped that the final effluent will be disposed of by soakage into the gravels on the old Ware sewage farm area. Joint consultants : J. D. and D. M. Watson, and D. Balfour and Sons ; main contractors (purification works), W. and C. French, Ltd., Kirk and Kirk, Ltd.

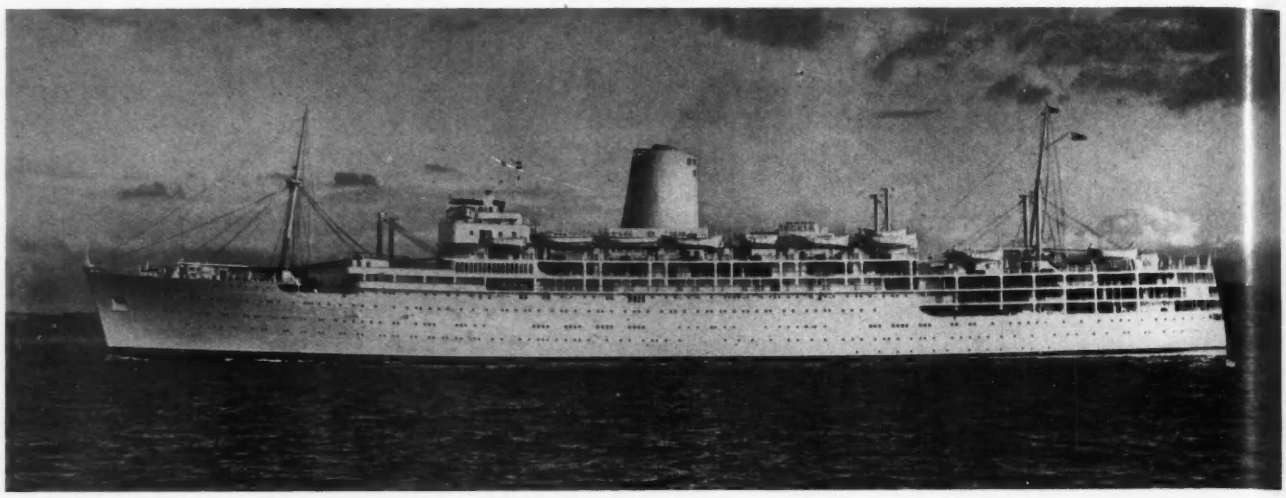


Aeration tanks, and final settling tanks in the background. There are four 835,000 gallons capacity aeration tanks, each with four passes, provision for incremental feed in the first two passes, and dome diffusers. The four final settling tanks are each radial flow tanks 92ft in diameter, with sludge removal by travelling scraper with multiple uptakes. Their total capacity is 1,880,000 gallons

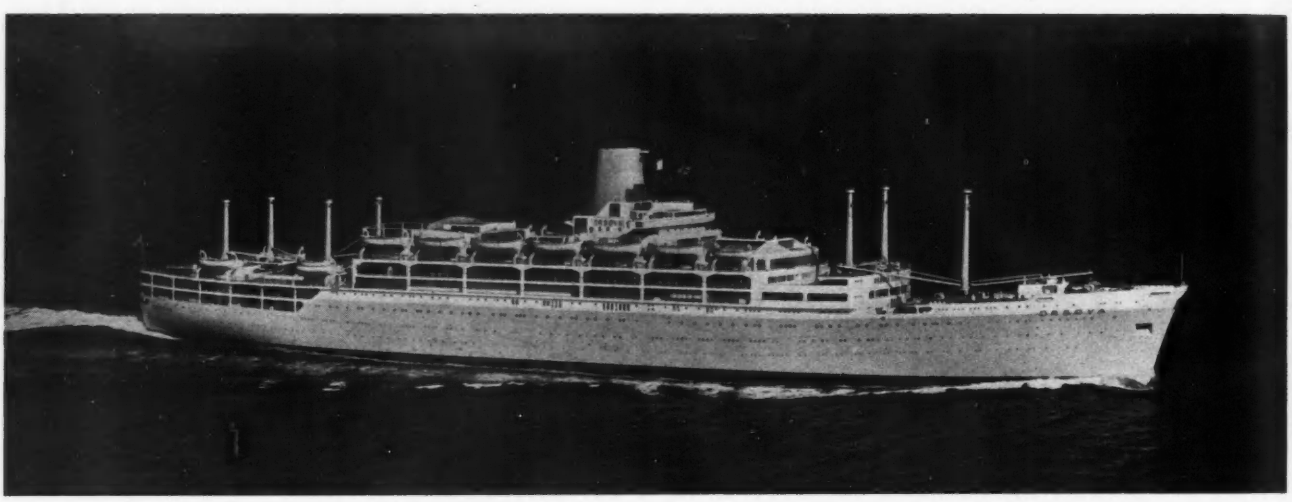


Inlet to the grit channels under construction. The main pump delivery channel which will feed sewage into the works is in the foreground ; it feeds through the three screening bays, which are to have mechanically raked screens, to constant velocity grit channels, shown in the background. Between the screening bays there are upward flow grit washers and screenings macerator chambers. Grit will be removed by travelling dredger

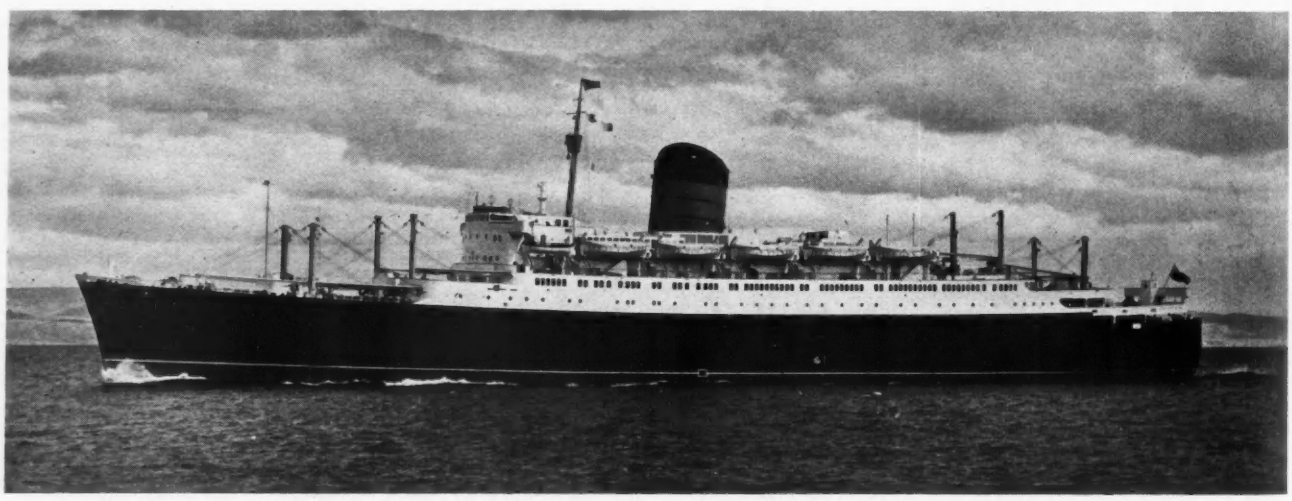
PASSENGER LINERS OF 1954



The P and O liner T.S.S. "Iberia" was built and engined by Harland and Wolff, Ltd. This ship has a length overall of 718ft 9in, a breadth moulded of 90ft 6in, a depth moulded to "C" deck of 49ft 9in, a gross tonnage of 29,600 and a service speed of 22½ knots. A total of 674 first-class and 733 tourist-class passengers are carried and the ship is propelled by a two-shaft arrangement of triple casing, Parsons geared steam turbines of 34,000 s.h.p. supplied with steam at 530 lb per square inch and 850 deg. Fah. by three Foster Wheeler boilers

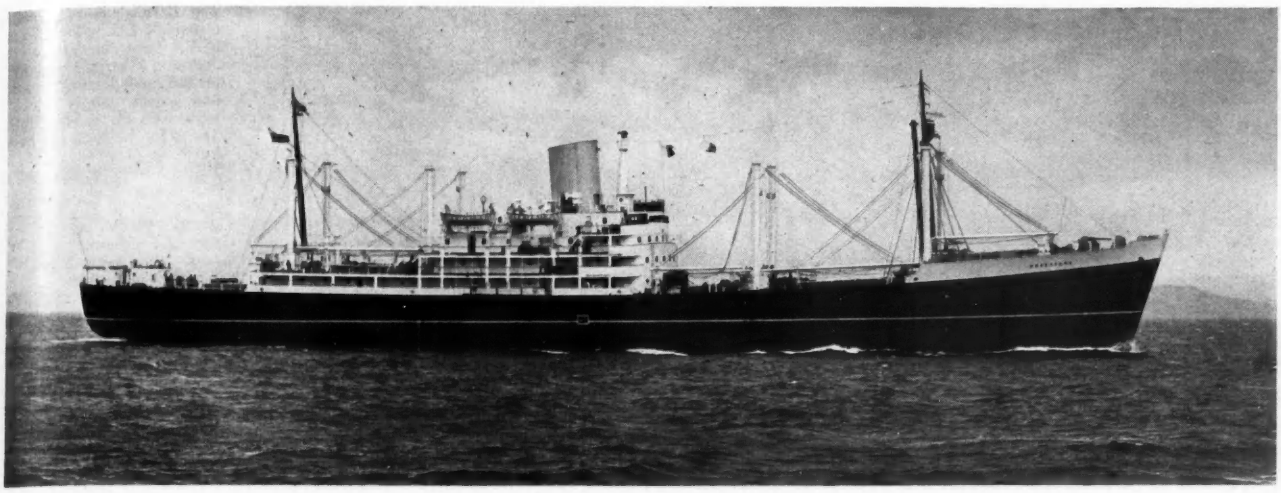


The Orient liner T.S.S. "Orsova", built and engined by Vickers-Armstrongs, Ltd., has accommodation for 681 first-class and 813 tourist-class passengers and the following main dimensions: length between perpendiculars 668ft, breadth moulded 90ft 6in, depth moulded to "E" deck 50ft, draught 30ft 9in, and a gross tonnage of 28,790. Two sets of double reduction geared Parsons turbines of 34,000 s.h.p. give a service speed of 22½ knots. Three Foster Wheeler boilers provide the necessary steam at 500 lb per square inch and 850 deg. Fah.

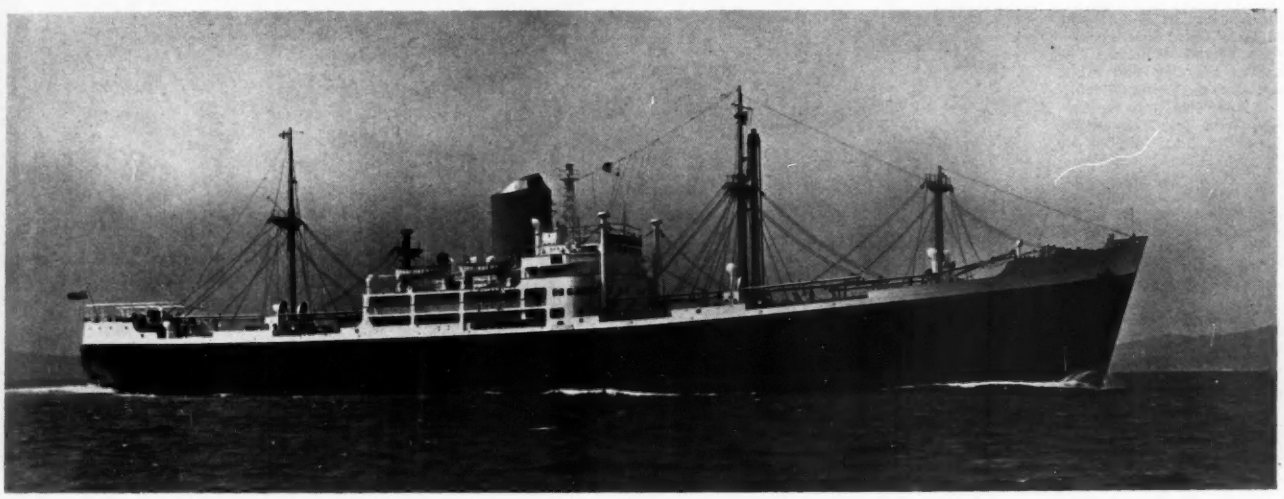


The Cunard liner T.S.S. "Saxonia" was built and engined by John Brown and Co. (Clydebank), Ltd., for the Canadian service of her owners, and the principal particulars are: Length between perpendiculars 570ft, breadth moulded 80ft depth moulded to "A" deck 46ft 3in, draught loaded 28ft, gross tonnage 21,637, and cargo capacity 300,000 cubic feet. Accommodation is provided for 125 first-class and 800 tourist-class passengers and the service speed of 19·75 knots is maintained by two sets of Parsons double reduction geared turbines which normally develop a total of 21,500 s.h.p. Four Yarrow, three-drum, end-fired water-tube boilers supply steam at 530 lb per square inch and 800 deg. Fah.

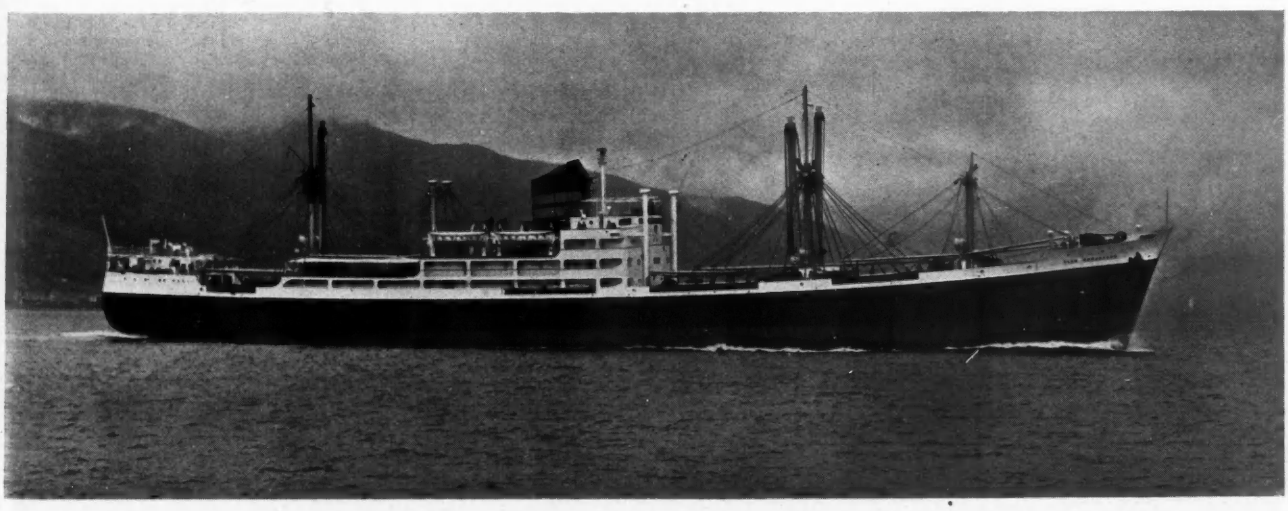
CARGO AND PASSENGER SHIPS OF 1954



Alexander Stephen and Sons, Ltd., built the M.V. "Whakatane" for the New Zealand Shipping Company's service between the east coast of Canada and the United States and Australia and New Zealand. The ship, which has accommodation for six passengers and a gross tonnage of 8750, has a length overall of 472ft by 62ft 9in breadth moulded and a draught of 30ft 6in. There are 95,000 cubic feet of insulated cargo space and 400,000 cubic feet of space for general cargo and the ship is propelled at a service speed of 16 knots by a Doxford oil engine. The engine, fitted with a Bibby-Doxford detuner, has six cylinders of 725mm bore by 2250mm combined stroke and develops 7100 b.h.p. in service at 114 r.p.m. with a m.i.p. of 82·5 lb per square inch

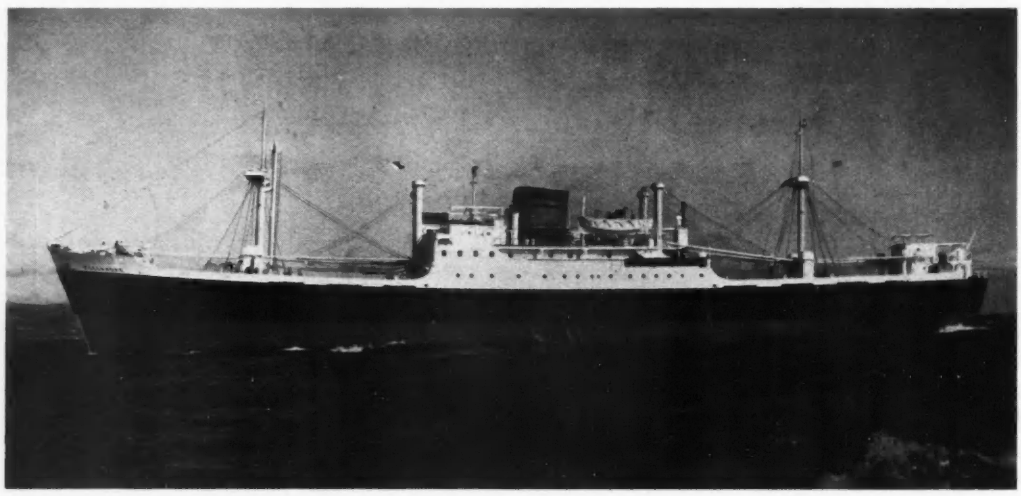


The S.S. "Cotopaxi," completed by William Denny and Brothers, Ltd., for the Pacific Steam Navigation Company, carries a deadweight of 11,100 tons on 28ft draught and has the following dimensions: length overall 512ft 6in., breadth moulded 66ft and depth moulded 40ft 8in. The ship, of complete superstructure design, has accommodation for twelve passengers, five holds and a derrick complement which includes one to lift 70 tons. A set of Parsons double reduction geared turbines give the ship a speed of 16½ knots and take steam at 450 lb per square inch and 750 deg. Fah., from two Babcock and Wilcox boilers



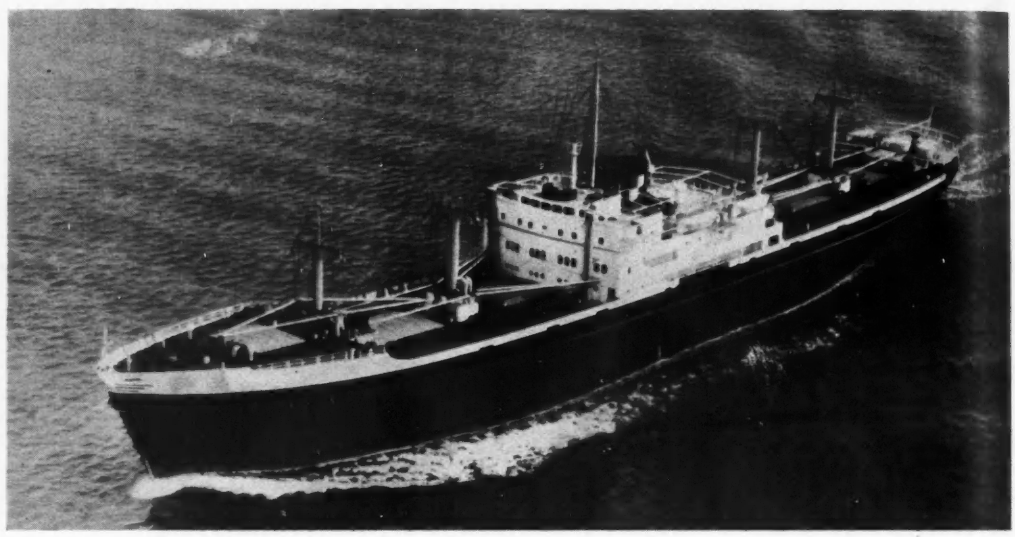
S.S. "Clan Robertson," has a length between perpendiculars of 465ft, a breadth moulded of 65ft 6in, a depth moulded to upper deck of 39ft 7½in, a gross tonnage of about 7775 tons, and carries a deadweight of about 10,100 tons on a mean draught of 27ft 3in. The Greenock Dockyard Company, Ltd., are the builders and The Clan Line Steamers, Ltd., the owners of the ship, which carries twelve passengers and has five holds served by nineteen derricks, including two of 40-ton and one of 80-ton capacity. A service speed of 17 knots is maintained by a three-casing set of Parsons double reduction geared reaction turbines which develop 9400 s.h.p. in service and are supplied with steam at 415 lb per square inch and 750 deg. Fah. by two Babcock and Wilcox single pass water-tube boilers

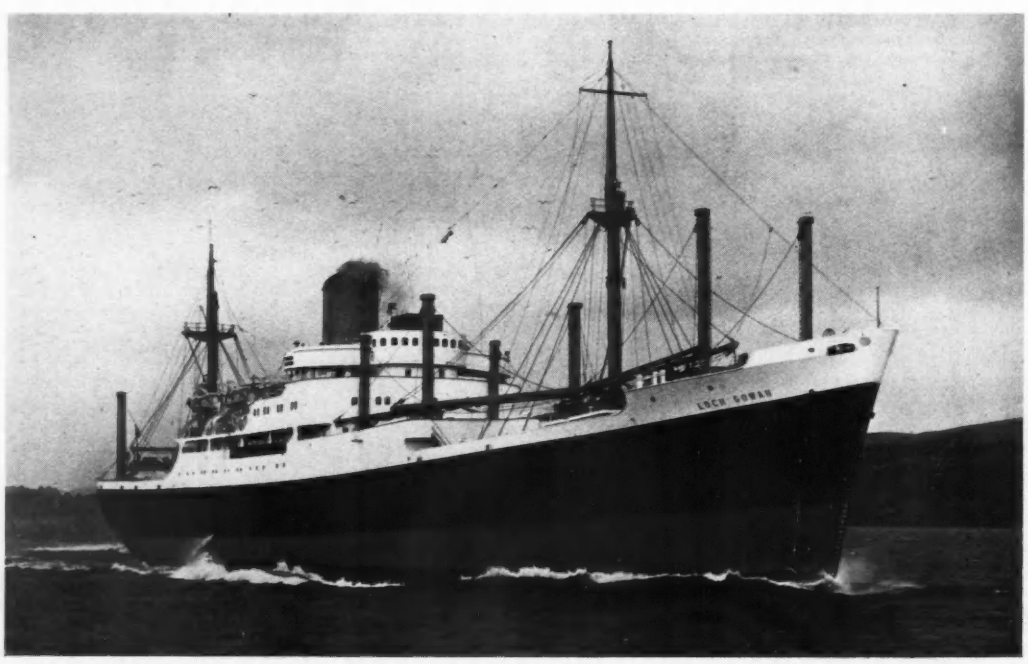
CARGO AND PASSENGER SHIPS OF 1954



The Burntisland Shipbuilding Company, Ltd., completed the M.V. "Beechmore" for the Johnston Warren Lines, Ltd., for the carriage of citrus fruits and general cargo. Twelve passengers are accommodated. The ship, which has a length between perpendiculars of 345ft, a breadth moulded of 52ft 7in, a depth moulded to shelter deck of 32ft 4in, and a draught loaded of 21ft 9½in, carries a deadweight of 4900 tons. There are four large holds served by ten 5-ton, two 10-ton and one 25-ton derricks operated by steam winches. Steam is supplied by one horizontal multi-tubular boiler and one vertical exhaust gas boiler, and the ship is propelled by a 3300 b.h.p. Hawthorn-Doxford oil engine having four cylinders of 600mm diameter by 2320mm combined stroke

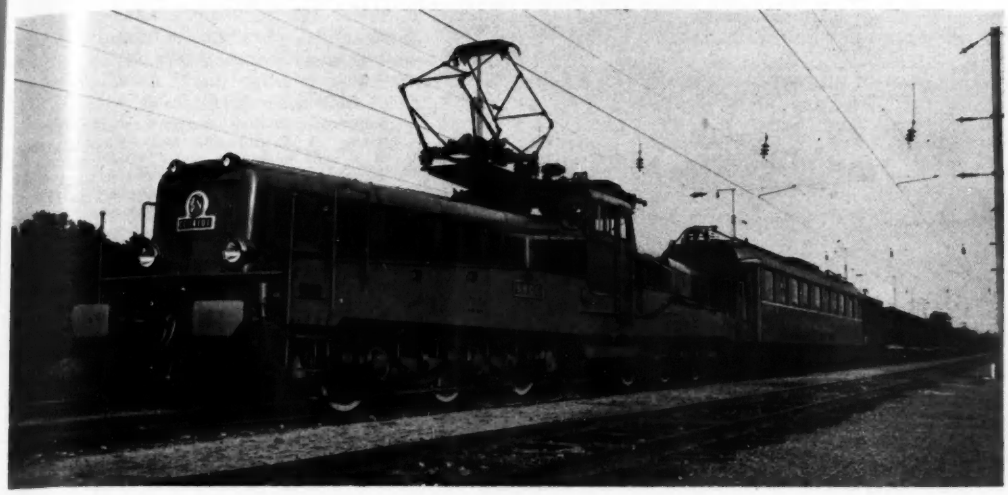
The open shelter deck cargo liner M.V. "Swiftpool," which carries a deadweight of 9870 tons on 27ft 3¾in draught and the following dimensions—length overall 485ft, breadth moulded 63ft 3in, and depth moulded to shelter deck 40ft 9in—was completed by the Caledon Shipbuilding and Engineering Company, Ltd., for Sir R. Ropner and Co. (Management), Ltd. Well-appointed public rooms and state rooms have been provided for a total of twelve passengers. The cargo is carried in six holds served by eighteen derricks operated by electrical winches, and the electrical requirements of the ship are met by three 200kW diesel-driven generators. A Stephen-Doxford oil engine of 7500 b.h.p. and having six cylinders of 725mm diameter by 2250mm combined stroke, is installed



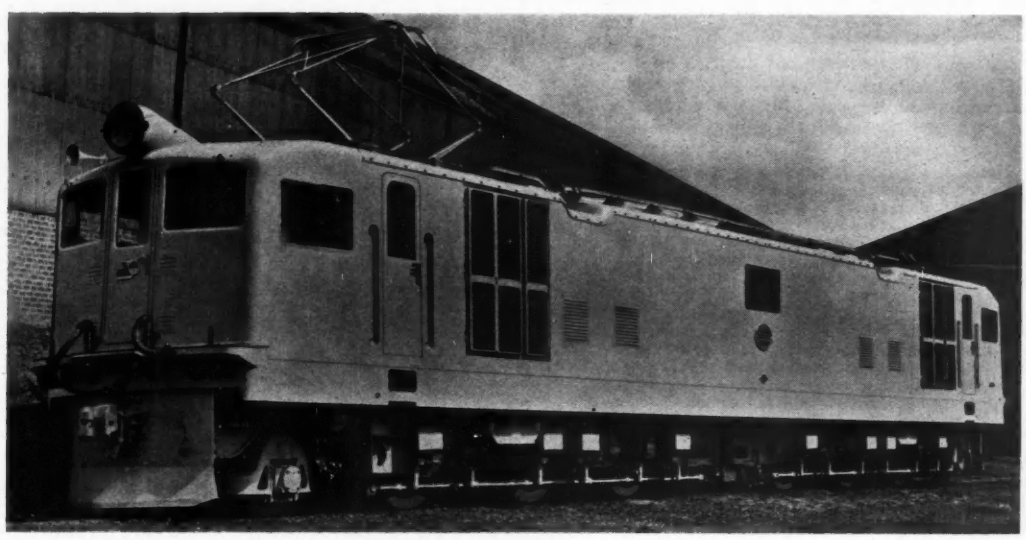


The turbine-driven cargo liner S.S. "Loch Gowan," of 9718 tons gross, was handed over to her owners, the Royal Mail Lines, by Harland and Wolff, Ltd., following successful sea trials. Comfortable accommodation is provided for twelve passengers, who have their cabins on the boat deck. There are three holds forward and two aft of the machinery space, and the derrick complement includes one 30-ton, four 10-ton, twelve 5-ton and four 3-ton derricks, served by electric winches. Electrical power for the auxiliary machinery and ship's services is provided by one 600kW turbine-driven generator and two 300kW diesel-driven generators, while the main propelling machinery consists of a single set of double reduction geared turbines. The triple-expansion, all-reaction turbines were constructed by the shipbuilders and deliver 10,500 s.h.p. in service at a propeller speed of 112 r.p.m., the necessary steam being supplied at 525 lb per square inch and 825 deg. Fah. by two oil-fired Foster Wheeler boilers

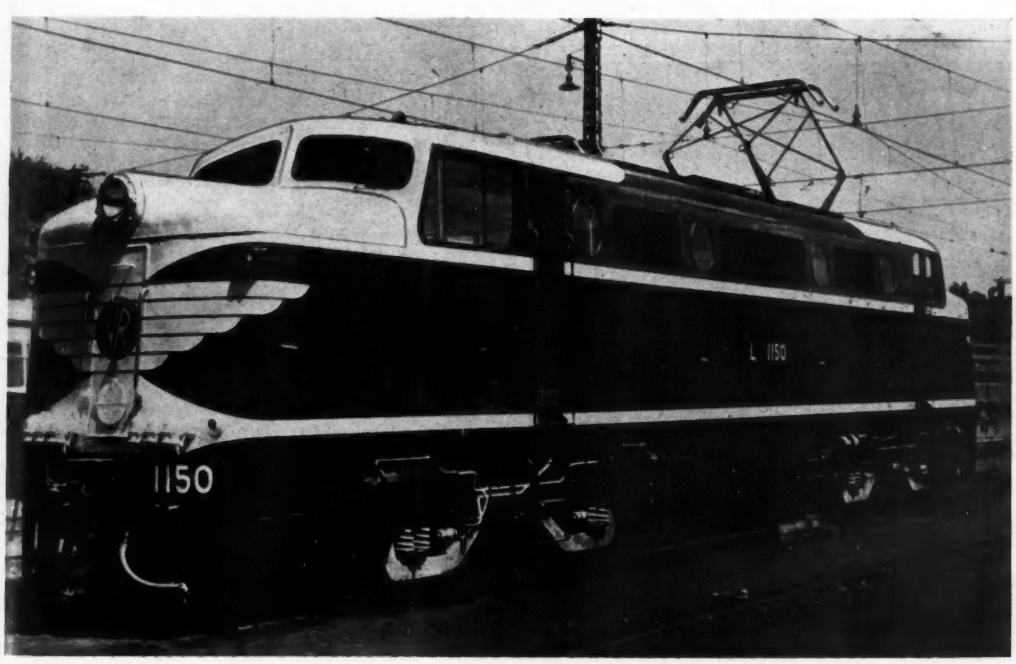
ELECTRIC LOCOMOTIVES OF 1954



The introduction of electric traction between Valenciennes and Charleville in 1954 ended the first stage of the French main line electrification, at 50 c/s single-phase, between Valenciennes and Thionville. Three prototype locomotives are in service; the heaviest of them (No. CC 14101, made by Alsthom) weighs 120 metric tons and here it is shown hauling a mineral train of 1800 metric tons, with a recording car immediately behind the locomotive

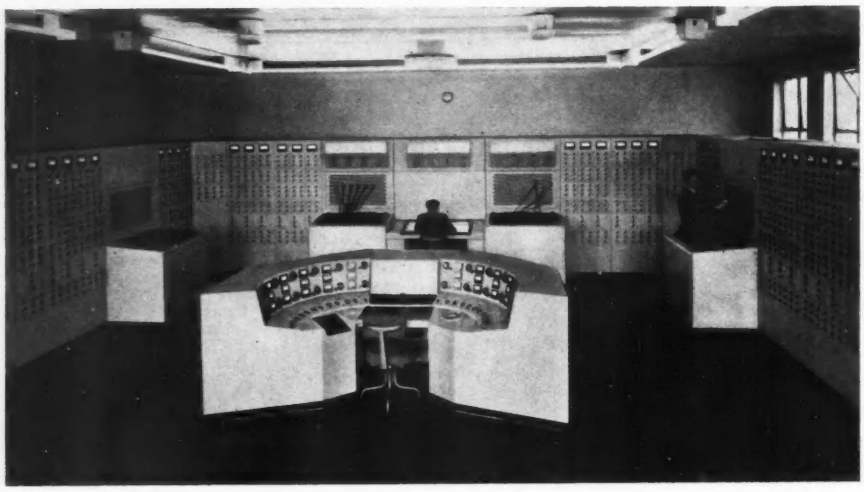


The 3030 h.p. locomotive shown here is one of forty being built for service on the 3000V direct-current sections of South African Railways. There are two bogies, each with three driving axles and a leading pony axle. Provision is made for three motor combinations, each with some field control, and for regenerative braking. The main contractor is the North British Locomotive Company, Ltd., the electrical equipment being provided by The General Electric Company, Ltd.

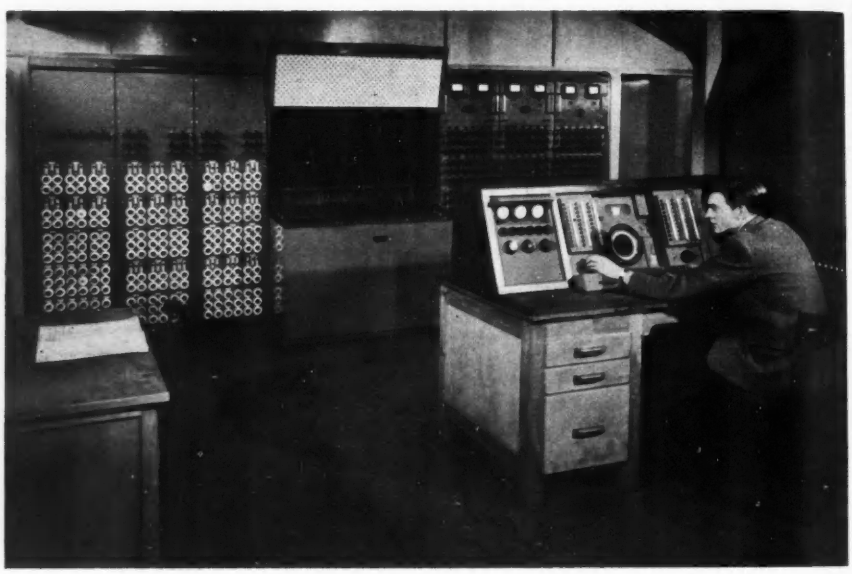


2400 h.p. mixed traffic electric locomotive for service between Melbourne and Traralgon, in Victoria, the first main line railway in Australia to be electrically operated. Twenty-five of these C_0-C_0 locomotives are being built by the English Electric Company, Ltd. The locomotives each weigh 96 tons in working order and have a maximum tractive effort of 54,000 lb, the continuous tractive effort at 30·4 m.p.h. being 25,200 lb. They are designed for a maximum service speed of 75 m.p.h.

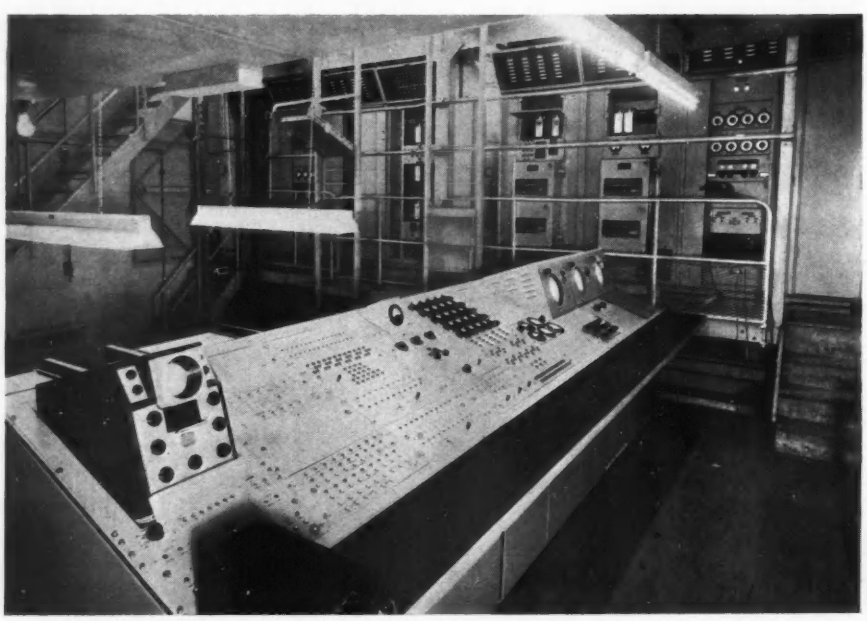
COMPUTERS AND NETWORK ANALYSERS OF 1954



Impedance network analyser at the Hebburn works of A. Reyrolle and Co., Ltd., where it is used mainly in power system studies and analogous work. It is of conventional design, except that the operating frequency is 1592 c/s instead of the more usual 500 c/s. There are twelve generator units, 120 line units, thirty-six load units, thirty-six auto-transformer units, and seventy-two capacitor units, which can be connected to simulate the elements of a given power system. Main metering is done from a control desk which houses an ammeter, a voltmeter, a wattmeter, a VAR meter, and a cathode-ray-tube phase-angle meter



Impedance network analyser built by the Electrical Research Association, Leatherhead, for studying networks in the steady state at a single frequency, or networks in a transient state, or for the study of the frequency response of networks. It is being built in self-contained stages. At present it consists of three steady-state generator units, two wings of impedance racks, a connecting and indicating board and a control desk for steady-state studies. The equipment to be added in later stages of the development of the analyser will include a separate control desk with measuring facilities for transient studies. The base parameters adopted for the analyser are 100 ohm impedance and 1592 c/s with a frequency range from one-tenth to ten times the base frequency



"TRIDAC," a three-dimensional analogue computer, is being used at the Royal Aircraft Establishment, Farnborough, in the solution of some of the complex mathematical problems associated with radar and guided missiles. In the accompanying illustration we show the control desk, with the three-dimensional display at the right-hand end. The basic analogue quantity in "TRIDAC" is a d.c. voltage and the basic element in most of the computing units is a high-gain d.c. amplifier with input and feedback impedances connected to give an overall transfer function corresponding to addition or integration. "TRIDAC" is the largest calculating machine in this country; forty-four cabinets are required to house the 2000 computing units consisting of some 600 d.c. amplifiers, 350 mechanical chopper stabilisers, and 250 modulator stabilisers. It was built by Elliott Brothers (London), Ltd., who designed the equipment jointly with the R.A.E.

service between Hull and Continental ports of the Associated Humber Lines. Each ship carries a deadweight of 1240 tons on 13ft 5in draught and has a length overall of 256ft, a length between perpendiculars of 240ft, a breadth moulded of 38ft 6in by 21ft 6in depth moulded to the shelter deck. There is comfortable accommodation for twelve passengers and the cargo is carried in three holds, each of which is served by two 7-ton derricks, with an additional 15-ton derrick at No. 2 hold. A Kincaid-Polar marine diesel engine is fitted and develops 2100 b.h.p. at 220 r.p.m. in service.

In July the raised quarter deck motorship "Rambler Rose," of which we reproduce a photograph, was delivered by John Lewis and Sons, Ltd., to Hughes Holden Shipping, Ltd. The ship, which is designed to carry bulk cargoes, is also arranged for timber carrying and has the following particulars :—Length between perpendiculars, 225ft ; breadth moulded, 36ft 6in ; depth to upper deck, 15ft 9in ; depth to quarter deck, 19ft 9in, and a mean draught loaded of 15ft 3in, corresponding to a deadweight of 1650 tons. All three holds, which are forward of the engine-room, have McGregor steel hatch covers and a single 3-ton derrick. To supply electrical power two 80kW and one 40kW diesel-driven generator sets are installed, and the main engine is a Lewis-Doxford oil engine having three cylinders of 440mm diameter by 1440mm combined stroke and developing 1100 b.h.p. at 145 r.p.m.

(To be concluded)

Coal in 1954

By SIR RICHARD A. S. REDMAYNE, K.C.B.

No. II—(*Concluded from page 9, January 7th*)

Supplies, Exports, Imports and Stocks of Coal

IN respect of the amount of coal exported, inclusive of bunkers, it is too early, at the time of writing, to know what the results have been ; but whereas in 1951, when 7,800,000 tons were included under "exports" (value £29,200,000), in 1953 this had risen to 14,000,000 tons (value £62,200,000), the highest, so far, since nationalisation of the mines. It is to be hoped that 1954 will show as good, if not a better, result, but it is doubtful.

As to imported coal, it is a tragic fact that we should still have to depend on this to the extent we have to, in order to meet our home demand for fuel. On June 21st last, when the Minister of Fuel and Power announced that he had authorised more imports, he was faced by an attack from Conservative M.P.s, but he refused to disclose—and, perhaps, rightly so in the circumstances—how much was being bought and where, because he wanted to give the Coal Board "the best commercial opportunities of getting it as cheaply as possible." Usually, the price is put at £2 a ton dearer than British coal.

The Minister showed that so far the quantity of coal stocked was less than the previous year ; compared with 1953 the balance sheet showed that at the date in question Britain had used 2,000,000 tons more, produced 1,000,000 tons more, stocked 1,500,000 tons less, exported (and bunkered) the same as last year. Asked who would foot the bill, the Government or the Coal Board, the Minister replied : "As in recent cases of imported coal, of which unhappily there have been many since the war, we must face the fact that it is the consumer who foots the bill." Later, a hint was dropped by the Minister's deputy, that if output did not increase prices of coal to the consumer may again have to go up.

On September 14th last, the 100 affiliated organisations of the Association of British Chambers of Commerce held a two days' conference at Sheffield, at which it was evident that the stage of anxiety in respect of coal supply had become one of worry as to the immediate future. Sir Hubert Houldsworth informed the meeting that coal stocks were down by 440,000 tons as compared with the same time the previous year, and that last year, too, there had been an additional reserve of 2,000,000 of opencast coal not available this year, and the "wintery summer" had made the position worse, causing consumption to rise by 1,000,000 tons.

It was estimated by the delegates at the meeting that about 6,300,000 tons more of coal would be required during 1954 than in the previous year. As Mr. G. M. Flather, the chairman, said in his opening address, "Unless the production effort in the coal industry is able to rise to the needs of industry as a whole, then Britain's economic outlook will be very gloomy indeed—the whole standard of living of the community will be jeopardised."

Compensation Payable to the Colliery Owners

The Minister of Fuel and Power announced in the House of Commons on February 22, 1954, that of the amount of the global sum of £164,660,000 awarded to the colliery owners, there had been paid to date £140,284,326. According to the report of the Comptroller and Auditor General, published on May 5th last, the total compensation payable to the erstwhile colliery owners in respect of the transference to the National Coal Board, under the Coal Nationalisation Act of 1946, it was estimated that the total payable was likely to amount to between £275 million and £300 million. It was added in the report that of that sum about £237,500,000 had been satisfied by December 31, 1953. It will be remembered that in addition to the collieries there are other assets to be compensated for, e.g. land, houses, brickworks, &c.

Safety and Health

Detailed statistics in respect of health and safety for 1953, which are compiled by the Ministry of Fuel and Power, are not yet available ; but it is most pleasing to learn that, according to the annual report of the Coal Board, issued on May 5th last, fewer men were killed and fewer injured in reportable accidents than in any year for which there are records, and the figure of 364 fatal accidents was forty-five below that of 1952.

The National Coal Board

In the article "Coal in 1953," which appeared in THE ENGINEER last January, mention was made of the intention of the Board to seek advice from some leaders of other large-scale organisations as to the desirability and, if so, the nature of any fundamental changes which should be made in the organisation of the Board. In May last, the Board published a directive which it had sent at that time to the staff. As to one's view of this, one cannot do better than quote extensively from the well-reasoned leading article which appeared in *The Times* of May 22nd last :

"The Board now publish the directive which they sent out at that time to the staff to clarify the relation of staffs at headquarter, divisional, and area levels, and to emphasise the intention that the area should be the main unit of management. It is not an impressive document. Delegation of authority by the Board to divisions or areas, the directive says, is 'unqualified' unless 'special reasons in particular matters' justify interference. How often, and on what sort of matter, will the Board, and, above all, the chairman, discover special reasons ? The headquarters retain responsibility for certain specified subjects, which include accounts, marketing and conciliation. The precise scope of the last is not defined, but it may indicate—and recent experience suggests that it does—a readiness at the centre to intervene too often and too precipitately in labour disputes.

"By contrast the position of headquarters planning and technical departments in the scheme of things, though not clear, seems to be 'writ small.' 'Management is expected to make full use of technical specialists as an advisory and consultancy service, but is free to decide whether to accept their advice.' It might well be supposed that 'management' in pits and areas should always be responsible for labour relations, subject to instructions on policy, but with no interference in administration from above, whereas it is unlikely to be, and at the moment usually is not, so expert on technical matters as the mining engineers at the centre. The directive calls for 'continuous contact' between the centre, the divisions, and the areas so that 'there may be frank and cordial exchange of information, views and ideas,' with the headquarters staff behaving as *primus inter pares*. These phrases, which recall descriptions of unsuccessful diplomatic talks, do not bear the imprint of resolute or effective leadership."

It is not the Board, composed as it is, of able and experienced members, which is to be condemned, but rather the nationalised system which it has to administer which is to blame for its inflexibility.

Legislation

"The Mines and Quarries" Bill came before the House of Commons in the spring of 1954, as amended by Standing Committee. This was a Bill "to make fresh provision with respect to the management and control of mines and quarries and for securing the safety, health and welfare of persons employed thereat ; to regulate the employment thereat of women and young persons ; to require the fencing of abandoned and disused mines and quarries, and for purposes connected with the matters thereof."

This Act for the first time comprises and embodies in one enactment provisions relative to coal and metal mines and quarries, also repealing the Metalliferous Mines Regulations Act of 1872 and 1875, the Quarries Act of 1887 and 1894, and all previous coal mines Acts. It received Royal Assent on November 25th.

It certainly was full time, in regard to the metal mines that the recommendations of the Royal Commission on Metalliferous Mines and Quarries, which was appointed in 1910

(incidentally, of which the present writer was a member) and reported on June 12, 1914, were carried into effect, as were also those, of the later Royal Commission on safety and health, in the coal mines. The Act authorises the making of regulations which will define requirements in greater detail. It will be of much interest to learn in due course the nature and extent of the regulations which may be introduced by the Government under this very important Act. Before they are in final form it is to be hoped that the Minister of Fuel and Power will afford opportunities for consultation with accredited representatives of the Institution of Mining Engineers, the Colliery Managers' Association, the Institution of Mining and Metallurgy, and the Institution of Chartered Surveyors, who obviously will be much interested and concerned therewith.

Damage from Subsidence

Much concern has of late existed on the subject of surface damage from subsidence, and National Coal Board teams working on the subject believe they are in sight of discovering how to meet the problem. It was considered that by manœuvring the underground operation—meaning, presumably, the workings—it may be possible to control surface movements and so ensure that buildings and installations are lowered in level without being damaged. But it will be some time, possibly a few years, before final conclusions are arrived at. Meanwhile, we are informed, a committee has been set up by the Institution of Civil Engineers, with architects and a representative of the Coal Board to study the effects of subsidence on different types of buildings.

On the subject of damage by subsidence, reference may be made to the findings of the Turner committee in 1949, which recommended that " every surface interest should be compensated for subsidence damage caused by the working of coal "—which is really a general right in Common Law. The state of the law has become, as the committee said, " chaotic and illogical." The late Labour Government introduced compensation only for dwelling houses with a rateable value less than £32, but not for other property or in respect of sewers and water mains. It has been argued that the Coal Board pays enough for damage by subsidence because it is a ratepayer, but that, surely, is false reasoning. The Turner committee recommended that one-third of the compensation should be paid by the N.C.B. and the rest by the Treasury, for, they said, " We appreciate the vital importance of not adding to the cost of getting coal." This would cause the Treasury to have to make the larger contribution towards the compensation. Why not carry into effect to the full the recommendations of the Turner committee ?

Developments in Mining Technology

Perhaps the most revolutionary development in coal mining technique in recent years in respect of the future getting of coal at the face, i.e. in what has come to be called " continuous mining," is by water infusion—the coal being got by drilling long holes into the coal face, sometimes as long as 7ft 6in and sometimes inclined (as determinable from the physical character of the coal), and the " softening " of the coal (lessening its texture by cracking), over the whole of the distance penetrated by the drill holes, by the infusion of water under pressure, sometimes as high as 370 lb per square inch, according to the strength and hardness of the coal. In order to infuse at high pressure a long tube " gun " may be required at one face, whereas a short tube gun may suffice at another face. The pressure causing the water to permeate the interstices of the coal " softens " it and so renders it more easily brought down by explosives or by such safety, low-pressure agents as " Hydrox," " Cardox " or " Airdox," or, mechanically, by coal ploughs or hammer drills. Though the " static " pressure may be high, the pressure-flow is much lower, and both decrease in the other holes after the first one or two. The subjoined tabular statement gives the particulars in respect of a recent trial with " Cardox " which came before the notice of the present writer. The holes were inclined at 40 deg.; the length of the holes was 7ft 3in (so giving horizontal distance of 5ft), and their distance apart along the face was 7ft.

Such comparatively low-pressure agents as " Hydrox," " Cardox " and " Airdox " are less violent in their effect on the coal than some other agents used, and so do not shatter the coal to the same extent.

The high-pressure water infusion, besides rendering the coal to be more easily got, performs also the highly useful safety function of prevention of coal dust. It is too early yet to determine what will be the extent of saving in cost which would result from the extensive application of water infusion in the breaking down of the coal, as compared with existing methods, but some estimates have put it as high as 50 per cent, which is probably an extravagant figure. More extensive practice only can determine what the saving will be, but there can be little doubt that it would result in the coal so got being of a much larger size and in the inducement to the wider application of its being mechanically loaded at the coal face.

Table IV—*Information Regarding Time, Rate, Infusion*

B20 shells release pressure (tons/sq. in)	Hole No.	Pressure, static, lb/sq. in	Pressure flow, lb/sq. in	Water used		Time after charging, minutes
				Before charging, gallons	After charging, gallons	
12	1	370	180	13	5½	2½
15	2	370	180	—	10	4
12	3	350	140	—	8	3
15	4	240	105	—	6	3½
12	5	150	100 (minus)	—	8	4½

Development in Gas Making

It was stated in the Press in March last that a new and revolutionary method of making coal gas had been evolved at Partington and Rochdale by the development of a method patented about thirty years ago. It consists of injecting gas into the base of the standard vertical retort during carbonisation and so accelerating the speed of gas making, more than double the usual amount of coal being so used, between 14 and 15 tons a day being put through regularly. The results were communicated to the Ministry of Fuel and Power. The method had been worked out over a period of two years by technicians of the North Western Gas Board. If the anticipated results are fulfilled, it has been estimated that the saving to the gas industry will amount to millions of pounds in capital expenditure and annual running costs.

The Coal Situation in Europe

Of what transpires behind the iron curtain we have but little accurate knowledge, so as regards the state of the coal industry in Russia and the satellite countries one can give little or no accurate information. Mr. John Lewis, president of the United Mineworkers (in America), early in January last, stated that foreign governments were using American dollars to buy coal in Soviet controlled markets such as Poland, Czechoslovakia and Manchuria. Writing in the *Mineworkers' Journal*, he said that the United States had been capable of exporting 50,000,000 tons of coal during 1953 " instead of a fraction of that amount, as current figures will reveal." Those figures showed that only 14,500,000 tons were exported, compared with 20,000,000 tons in 1952 and 57,000,000 tons in 1951. The unrealistic trade policy — which results in giving American dollars instead of selling American goods—plus exorbitant shipping costs, caused a sharp decline in oversea exports of bituminous coal.

We are, however, at the present chiefly concerned with what has transpired in regard to those countries which are within the European Coal and Steel Community and, in particular, with its possible effect on and relation to the coal industry of other countries, especially Great Britain.

It had been known for some time that Monsieur Monnet was most desirous of establishing a closer association between the United Kingdom and the coal and steel pool, but the precise form of the proposals he had in mind were not then available. On December 30, 1953, consultations were commenced between the Government departments concerned on a communication which had been received from Monsieur Monnet (president of the High Authority of the European Coal and Steel Community) on the 24th of that month, which raised, formally, the question of the closer association. Hitherto the Authority had, as explained in last year's article in THE ENGINEER, been heavily engaged in the work of internal organisation and in starting the common market. In relation to the United Kingdom, the discussions and negotiations would appear to have pertained to such matters as to how far we, in this country, could participate in the common market by, for instance, reducing, if not abolishing, tariffs, relaxation of quantity restrictions on imports of the Community's coal and steel into the United Kingdom, and rules for the governing of competition. Monsieur Monnet has always, too, been of the opinion that collaboration would require the establishment of a small joint body representing Great Britain and the Authority, clothed with executive power. It will be seen, therefore, that under such conditions as adumbrated above (if, indeed, they are such as those proposed), the institutional link would have gone much further than the existing liaison mission under Sir Cecil Weir at Luxembourg. It was hoped by the High Authority that Britain would adopt the American Government view, in that it resolved to deal with the Community on questions concerning coal and steel instead of negotiating separately with individual countries contributing to the common market. As has been previously explained (in last year's article) Britain and the High Authority have hitherto been exchanging information. A joint committee consisting of the president and several members of the High Authority, and the British delegation, together with officials and experts has considered problems of common interest.

It may be mentioned that as stated at a

meeting of the Common Assembly of the European Coal and Steel Community under the presidency of Monsieur Spaak at Strasbourg on January 14th last, the estimated revenue for the first quarter of 1954 amounted to 45,000,000 dollars, which the High Authority had allotted : (1) 35,000,000 dollars to set up a fund for the guaranteeing of the loans which it would contract ; (2) 7,000,000 dollars to provide for readjustment ; (3) 1,000,000 dollars as a first instalment, for technical and economic research into production and safety measures. It was expected that administrative expenses of the High Authority would not exceed the remaining 5,000,000 dollars. Monsieur Monnet informed the meeting that he hoped the activities of the Community would be extended by the association which it hoped to establish with Great Britain. He stated, too, that the High Authority was negotiating with the Government of the United States of America for a loan. At this meeting criticism was forthcoming at the large number of officials employed—there being eighty-nine temporary employees in relation to seventy-eight delegates.

By the beginning of March no decision had been made by the British Government as to the answer to be sent to Monsieur Monnet's invitation for closer British association with the European Coal and Steel Community.

On May 3rd last the British Government published as a White Paper correspondence between Monsieur Monnet and the Government with Monsieur Monnet's proposals for the association already referred to. In reply to which the Government invited Monsieur Monnet to visit London and discuss the precise form of the proposed association. On April 30th Monsieur Monnet accepted the invitation.

The political arguments in favour of closer association with the Community on the lines suggested by Monsieur Monnet are very strong. But those from the purely commercial point of view are not, for Great Britain in regard to its coal and steel industries is well able to meet any competition from the Community. British coal and steel costs are well below the Continental level, and the outlets for steel in the shape of overseas markets is very secure. But, on the whole, British current opinion favoured some form of closer association.

Owing to Monsieur Monnet's illness, the discussion with him had to be deferred. But it was announced in the Press of October 2nd that our Minister of Supply, Mr. Duncan Sandys, had had informal talks, in Paris, during the last week in September, with Monsieur Monnet, Herr Etzel and Mr. Spierenburg, members of the Authority, on the subject of future relations between the United Kingdom and the Community. Mr. Sandys was accompanied by Sir Cecil Weir. The purpose of the meeting was to pave the way to the formal discussions which were to take place in London later.

At a meeting of the Council of Ministers of the European Coal and Steel Community, held in Luxembourg on November 22nd, the terms of agreement on closer co-operation with Britain were, with the exception of some amendments, unanimously accepted.

At a meeting of the Common Assembly of the European Coal and Steel Community, held at Strasbourg on November 30th, Monsieur Monnet, speaking on the subject of the relations with Britain, said that the draft agreement had been submitted to the Council of Ministers, adding that " the essential characteristic of the agreement is that of a constantly growing association, with complete reciprocity between Great Britain and the Community."

British Iron and Steel Industry in 1954

THROUGHOUT last year, the outstanding rate of progress which has been characteristic of the British iron and steel industry since the war, was continued. It was the first full year of " denationalisation " and despite the complexity of the financial problems involved, there was no particular difficulty encountered in the process of returning the industry's assets to private ownership. The Iron and Steel Board, established by the Iron and Steel Act, 1953, " to exercise a general supervision over the industry," undoubtedly carried out its tasks wisely and well, with the result that in 1954 the industry was able to function free from the disturbing effect of political interference. Apart from all these factors, the iron and steel industry last year again derived increasing benefit from the completion of its first post-war expansion programme, and from the progress made with its second development plan.

Output and Supplies

Production of steel ingots and castings last year reached a total of 18,520,000 tons, and pig iron output amounted to a total of 11,883,000 tons. The year's output would probably have been somewhat higher had there not have been a mechanical breakdown on some North-East Coast plant and an unofficial strike of coke-oven workers which brought the Margam plant virtually to a standstill for some days in July. This unofficial stoppage at Margam, incidentally, was an unusual event in the recent history of the British iron and steel industry, which for many years now has maintained a particularly good record of labour relations.

Despite these two " hitches," however, steel output in every month but one in 1954 was higher than in the comparable month of the preceding year. When the year's total is considered, it should not escape attention that British steel production has gone up by nearly 6,000,000 tons, or 45 per cent, since 1946, an increase fully comparable with that which has occurred in the U.S.A. in the years since the war. In 1953, steel production amounted to 17,608,500 tons, and quite early in 1954 it became evident that an addition of the order of 1,000,000 tons might be expected. In all the steel-making districts, except Scotland and the North-West Coast, increased production was recorded, particularly notable advances being made in South Wales, the North-East Coast, Lincolnshire and Lancashire. The increases in these districts especially reflected the expansion of capacity. Last year's output from the North-East Coast area, for example, shows the effect of the Lackenby melting shop of Dorman, Long and Co., Ltd., where four open-hearth furnaces were in production from the beginning of 1954 and a fifth was started up in May. New plant at Consett also added its quota to the increased output in the area. The extensions at the Shotton plant of John Summers and Sons, Ltd., were among those which added to the output of the Lancashire and Cheshire district. In Lincolnshire, pig iron output rose as a result of the blowing in of two new blast-furnaces, of 27ft and 28ft 6in diameter respectively, which are an important part of the " Seraphim " project of the United Steel Companies, Ltd., at Scunthorpe.

Whilst, however, last year was, when looked at overall, a year of considerable progress, it has been found that the progress was somewhat uneven. In the earlier months, business in some sectors of the steel industry was relatively quiet. The business recession in the U.S.A. was still apparent, and probably there were steel consumers in this country who were inclined to take a cautious view. But during the second quarter, the demand for steel quickly gained momentum and before the end of the summer producers' order books were full. By the end of the year, the industry was operating virtually at capacity. With the continuing increase of home steel production, of course, most of the requirements of the consuming industries at the beginning of last year could be satisfied and consequently there were reduced imports. The British Iron and Steel Federation has said, in fact, that the running down of order books caused many producers to intensify their search for outlets overseas, in which they were assisted by the relaxation of official restrictions on the export of steel. But in some instances these additional export commitments turned out to be somewhat embarrassing when home orders increased very rapidly in the middle of the year. Imports of finished steel—but not of semis—were therefore rather larger in the second half of the year than in the first, but it is estimated that for the whole of the year they will not have amounted to more than 500,000 tons, compared with 1,110,000 tons in 1953.

Figures showing the extent of finished steel deliveries in 1954 are not likely to be available for a month or two. It has been estimated that home deliveries for the year may have amounted to 16,600,000 tons and export deliveries to 2,900,000 tons. A fairly reliable assessment of the situation can be made, however, from a study of figures showing the weekly average deliveries over the twelve month period ended September, 1954. Deliveries of all descriptions of finished steel in that period averaged 270,400 tons a week, which was 5 per cent above the weekly average over the twelve months ended September, 1953. But, as already noted, experience in the different sectors of the steel industry in some months of last year was by no means uniform. Throughout much of the year products showing a more than average increase were rails, heavy sections and bars, wire rods, sheet, strip, tinplate and railway tyres, wheels and axles. On the other hand there was some reduction in deliveries of light sections and bars, tubes, forgings, and high-speed tool and magnet steel. There were, no doubt, several factors which accounted for the differences in demand, as, for example, some decline in rearmament orders, uneven progress in some of the consuming industries, and divergent movements in consumers' stocks.

At the beginning of last year, about the only " difficult " items from the supply aspect were steel plates and sheets. Demand for plates, particularly from the shipyards, railway wagon builders and the oil industry, had been showing a rapid increase in the preceding years, but as 1954 proceeded the situation certainly became easier. New plate rolling capacity meant increased production, and, generally speaking, by the end of the year, most requirements were being met. Steel sheet supplies, however, continued to present difficulties. The motor vehicle industry's requirements con-

tinued to grow and there were increased demands from manufacturers of containers and many domestic appliances. Although the stoppage at Margam in the summer affected sheet production a little, it is estimated that the total deliveries of sheet last year were about 15 per cent higher than in 1953. In order that the whole of the increase could be devoted to home demands, exports were kept down to a quantity below the 1953 level, but even so home supplies of sheet had to be supplemented by about 175,000 tons of imports, which entered the country duty-free throughout the year.

As to tinplate, there was last year a significant recovery from the rather depressed conditions which prevailed during 1953. It will be recalled that, with the steady building-up of production from the new plant at Trostre, tinplate supply had overtaken demand in the early part of 1953, a factor which led to the closing down of some of the old hand mills. The recovery of home orders was delayed by the need for consumers to use up the stocks they had accumulated to help to keep their production going and by the time taken to overcome the effects of Government restrictions on the use of tinplate, which were removed in 1953. When home demand for tinplate did recover, however, it rose to a very high level, and as it was not possible to reopen all the closed mills, consumers could not be entirely satisfied from home sources without a serious reduction in tinplate exports. As this was considered to be undesirable, it was decided before the end of the year to suspend the import duty on tinplate to enable the principal producers to import the extra quantities needed.

Light rolled steel products, according to a survey made by the British Iron and Steel Federation, constituted a group in which demand at the beginning of last year was not altogether keeping pace with increasing production. It has been suggested that a point was reached where some plants making bars and wire rods were working below capacity. By the middle of the year, however, the demand was rapidly strengthening, so much so that there were delays in delivery and, in some instances, actual shortages. Production was restored to the maximum as quickly as possible, although at some works there were difficulties in recovering the labour that had been lost. Growing demands early last year for building work and mine roof supports caused shortages in joists. At several plants Sunday shifts were worked, but as the year ended production of this material had still not overtaken demand, although imports were helping to relieve the pressure.

Raw Materials

The expanding production of the iron and steel industry cannot, of course, be maintained or continued without adequate supplies of essential raw materials. Happily, last year these occasioned no serious anxiety. In the second development plan, upon the fulfilment of which the industry is now engaged, a major factor is the increase of blast-furnace and coke oven capacity. In 1953 the steel industry's direct coal purchases amounted to nearly 21,000,000 tons, in addition to which about 3,500,000 tons of coke were bought. Roughly two-thirds of the coal was for coking purposes, and provided approximately 70 per cent of the industry's requirements of blast-furnace coke. These figures will certainly have been exceeded last year. At the same time, it should not be overlooked that the new blast-furnace and coke oven capacity which is being commissioned is designed for greater efficiency in operation.

Production of home ore is now declining, and before last year ended some mines in the Cleveland area had been closed. New ore mining projects are being developed in the Midlands, and whilst the greater part of the industry's ore requirements continue to be met from home sources, the quantity of foreign ores used is increasing. During last year imports of ore averaged nearly 1,000,000 tons a month, much of which came from Sweden and Algeria.

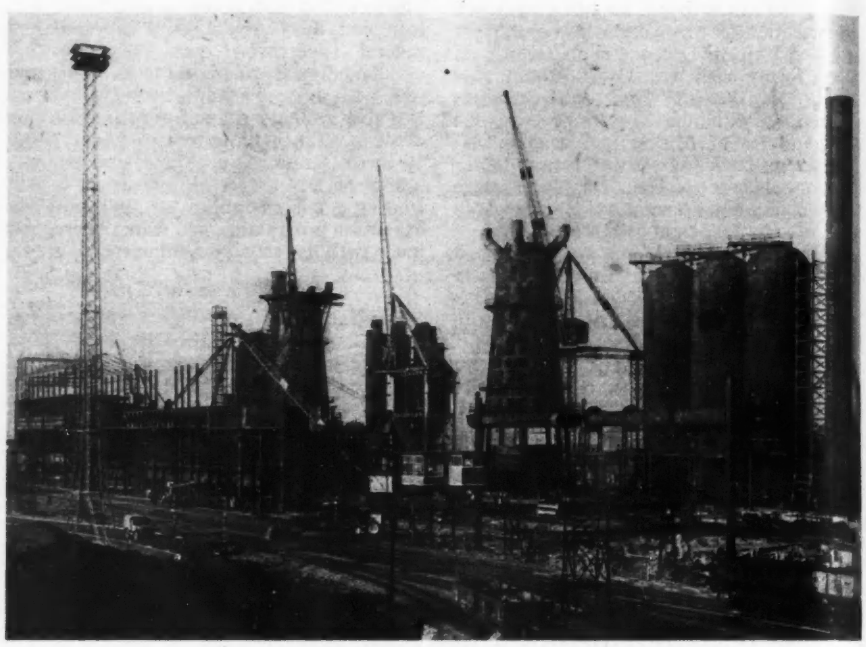
A factor of no little significance in blast-furnace efficiency is the contribution made by the use of sinter. The sintering process converts ore fines and other finely divided iron-bearing material into a product suitable for blast-furnace use. It thus becomes more economic to eliminate all fines from the raw ore before it is charged into the furnace, a process which improves the productivity of the furnace and reduces the coke consumption per ton of iron. Schemes which have been approved, and some of which are in the construction stage, will increase the output of sinter to somewhere around 9,000,000 tons a year by 1958.

Although the development programmes envisage the consumption by the steel furnaces of a larger percentage of pig iron and a consequent reduction in the percentage of scrap, there was a continued demand last year for steel making scrap. Supplies were well maintained from home sources, and although the scrap drive, initiated some years ago by the British Iron and Steel Federation, has virtually ended, the benefits derived from it have not disappeared. All through last year, stocks of scrap at steel works and foundries increased, and, from figures so far available, it would seem that imports may have been about 100,000 tons less than in 1953.

Iron and Steel Prices

There were some price changes in iron and steel products which took effect last year. These changes, which were made in May and December, respectively, resulted from a general review of the price level and structure which was made by the Iron and Steel Board. The changes meant that, generally, maximum prices of iron and steel were advanced by about 3 per cent, although in the case of some products the adjustment led to a small price reduction.

In its review, the Iron and Steel Board followed the general principle of determining maximum prices by reference to production costs and margins for depreciation and profit. Account was also taken of the fact that steel which is imported is resold at home market prices which are below the prices at which imports are purchased. When it announced the revised prices, the Board pointed out that there had been substantial increases in the capital employed per ton of product and in the level of capital costs since margins had last been determined in 1949. The margins were therefore adjusted to take account of those factors and other changes in circumstances since then. There were some significant increases in production costs last year, notably in relation to coal, coke and transport. But there were also substantial savings resulting from a fall in the price of imported raw materials, a reduction in the quantity of imported steel, and from increased efficiency brought about by the installation of modern plant. Even with the price changes, however, home trade prices again last year continued to be lower than those ruling in the other main steel producing countries of the world.



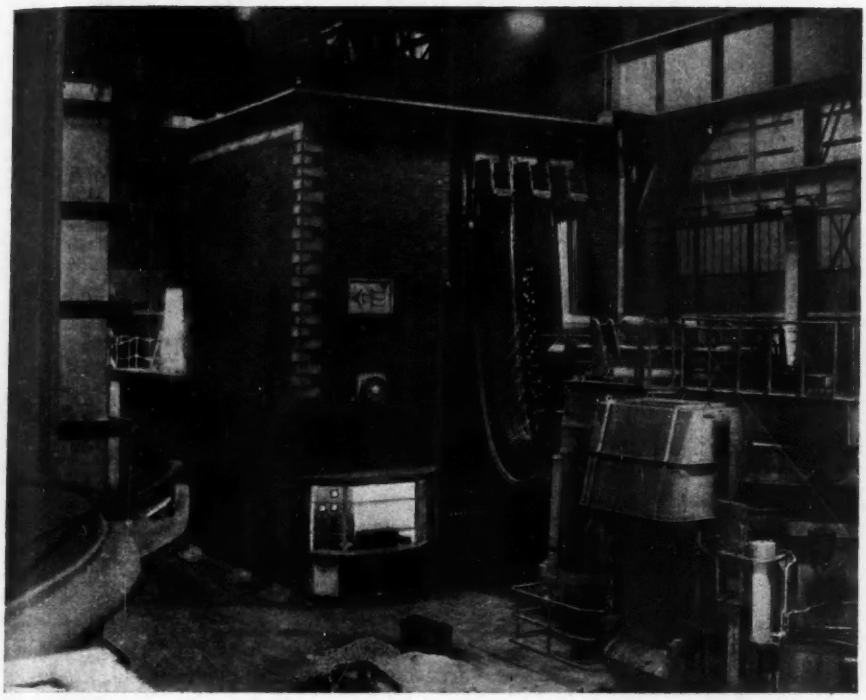
Construction of two new blast-furnaces at Cleveland works. These furnaces, which are 27ft 6in hearth diameter, will have a combined annual output of 750,000 tons of iron

European Coal and Steel Community

An event of considerable importance to the British iron and steel industry last year was the signing in December, of an agreement between the United Kingdom Government and the High Authority of the European Coal and Steel Community. Since the Community came into being in 1952, there has been a regular exchange of views between it and a United Kingdom delegation, and the United Kingdom Government at the outset declared its desire for an "intimate and enduring association" with the Com-

munity, even though it felt that it could not be bound by the principles of membership. The agreement signed just before Christmas followed twelve months of negotiations. It provides for the establishment of a "Standing Council of Association" consisting of four representatives of the British Government and four representatives of the Community's High Authority. One of the British representatives on this council will be a member of the Iron and Steel Board.

The White Paper detailing the terms of the agreement explains that the Council of Association will provide "a means for the continuous exchange of information and for consultation in regard to matters of common interest concerning coal and steel and, where appropriate, in regard to the co-ordination of action on these matters." Matters of common interest have been defined as including conditions of trade between the Community and the United Kingdom; supplies of coal and steel and supplies of raw materials; pricing arrangements and factors affecting the price structure; production and consumption trends; effects of the development of other sources of energy and substitute materials on coal and steel requirements; technical developments and research, and arrangements for the promotion of safety, health and welfare of persons employed in the industries.



60-ton electric arc melting furnace at Stocksbridge. This furnace, with an output of 1200 ingot tons a week, is primarily for the production of low alloy steels

Development Programmes

Reference has already been made in this review to the development programmes undertaken since the war by the iron and steel industry. The first of them, which was originally designed to increase steel making capacity to 16,000,000 tons by 1953, was subsequently extended and virtually completed by the end of 1952. The capital expenditure involved in the carrying out of this programme was in the region of £400 million.

Before the completion of its first programme of replacement and modernisation, the industry had decided upon a second post-war development plan, the fulfilment of which envisaged a further increase of ingot capacity to 20,500,000 tons a year by 1957–58. The cost of the work involved in this plan was estimated at £250 million, based on prices ruling in 1952. In Plates 12 and 13, which are included in this issue, there are illustrated examples of the works which formed a part of these development plans. Last year was the first full year of operation of the new open-hearth steel making plant erected at Lackenby, on the North East Coast, by Dorman, Long and Co., Ltd. The melting shop at Lackenby contains five 360-ton furnaces and two 600-ton mixers, and in the second half of last year all were in continuous operation. On the same site, adjacent to the open-hearth plant, work is now in progress on the installation of a 3000ft long combined universal beam and heavy section mill which will have an annual output of 400,000 tons of heavy structural steel products. Alongside the beam mill a billet rolling train is to be built to produce the extra semi-finished steel requirements of a high-capacity rod, bar and narrow strip mill which is also to be laid down at Lackenby.

At the Cleveland works of Dorman, Long and Co., Ltd., two new 27ft 6in hearth diameter blast-furnaces are being built. The stage reached in their construction just before the end of last year is shown in the illustration on page 54. Together, these furnaces will have a capacity of 750,000 tons of pig iron a year. They will be linked by belt conveyors with the ore preparation plant, the capacity of which has been doubled, and with the existing coke ovens at the Cleveland works. A new coking plant, consisting of 150 ovens, is also being built at Cleveland and will be capable of carbonising 1,300,000 tons of coal annually.

The illustrations on Plate 13 show the blast-furnaces and other plant forming the major part of the "Seraphim" project at the Appleby-Frodingham works, Scunthorpe, of the United Steel Companies, Ltd. The first of the new furnaces, named "Queen Anne," was blown in on March 1st last, and the second furnace, "Queen Victoria," was started up on July 29th. This latter furnace, which has a hearth diameter of 28ft 6in, is so far the largest in commission in Europe. These two furnaces have an annual output approaching 600,000 tons of pig iron, and their completion has enabled some older furnaces to be taken out of commission. A particularly important point about these new furnaces is that they are operating on a 100 per cent sinter burden. The sinter plant, consisting of four continuous moving pallet strands 72in wide and 168ft long with twenty-eight windboxes, is capable of producing 28,000 tons of sinter a week from Frodingham and Northamptonshire ores.

At the Stocksbridge works, Sheffield, of Samuel Fox and Co., Ltd., a new melting shop was put into service towards the end of the year. It is equipped with a 60-ton electric arc melting furnace, which is illustrated herewith. This furnace, which was made by Birlec, Ltd., under licence from the Pittsburgh Lectromelt Furnace Corporation, has an output of about 1200 ingot tons a week. It is a top-charged, direct-arc tilting furnace equipped with three automatically adjusted, vertical carbon electrodes; each electrode being 20in in diameter, 6ft long and, with its supporting arm, weighing 20,000 lb. A description of the melting shop and furnace appeared in our issue of December 17th last.

There was, of course, similar progress last year with other extensions and development projects in the iron and steel industry. At the Shotton plant of John Summers and Sons, Ltd., and at the Ebbw Vale works of Richard Thomas and Baldwins, Ltd., hot and cold continuous sheet mills were in full operation. A continuous bar mill at the Park Gate Iron and Steel Company, Ltd., and a rod and bar mill at the Warrington works of the Lancashire Steel Corporation, Ltd., were other items of new equipment which were in full production.

Conclusion

As the year ended, it was evident that further additions to iron and steel making capacity would reach completion in 1955. On the blast furnace side this increase of capacity is likely to be considerable. This obviously emphasises the need for more coke, almost all of which will be provided from the industry's coke ovens. The additional pig iron will provide, of course, the essential basis for a further advance in steel production in the current year, possibly to between 19,250,000 tons and 19,500,000 tons. If such an output is reached this year, then the industry should be more than able to meet the requirement of 21,000,000 tons estimated some time ago for 1957–58. This, the British Iron and Steel Federation has said recently, is as it should be. It is always desirable that the iron and steel industry should be somewhat ahead of requirements rather than that it should lag behind them.

Projectile Plotting by Radar.—Orders have been placed by the Royal Air Force and the British Army for radar equipment which, by detecting the columns of water raised by projectiles when striking the sea, will be used for plotting purposes at bombing and gunnery ranges. The radar apparatus ordered is a special version of a standard Decca equipment for airfield control. A set will be installed at the practice bombing range on the Lincolnshire coast at Saltfleet, and it will mark the first occasion on which the R.A.F. has used radar in this way. Another set will detect shell splashes from guns fired on the range at Shoeburyness, and will also make it easier to locate any shipping which might stray on to the range during target practice, thus improving the present stringent safety precautions.

Gas Turbines in 1954

No. I

DETAILS of the progress made with the major industrial gas turbine projects in this country, many of which are sponsored by the Ministry of Supply, were again last year largely withheld from publication. Design details of these installations have been re-given in past reviews in THE ENGINEER, and since they were first discussed by Sir Harold Roxbee Cox little further information has been released.

Amongst smaller gas turbines, that made by Ruston and Hornsby, Ltd., was adapted during the year to burn methane fuel. The basic TA unit is regarded as being the most successful in its field and is in batch production at the company's Lincoln works. Some twenty-five units have been ordered and the combustion equipments now developed for use with this series include those for diesel oil, tar fuel and peat. The design set was conceived in 1945 and the set first ran in 1949. It aims to achieve a long life with a design based on aeronautical engine practice and employing a moderately high maximum temperature of 730 deg. Cent. The gas generating element has a shaft speed of 11,400 r.p.m., the speed of the power turbine being 6000 r.p.m.

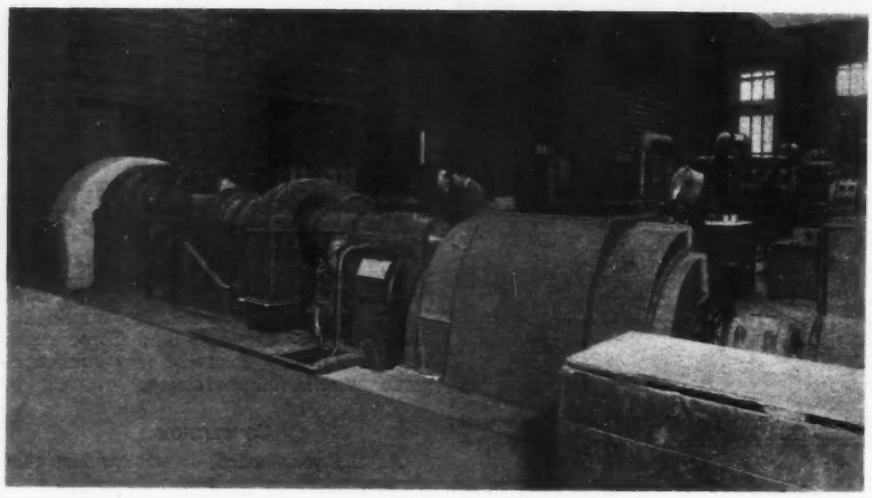


Fig. 1—1500kW gas turbine installed at the Ashford Common filtration works. It works on the simple open cycle with a rotor speed of 7000 r.p.m. and a maximum temperature of 1250 deg. Fah.

Last month we learned that the Ashford Common filtration works of the Metropolitan Water Board had received the first of three 2500kW gas turbines. It was supplied by Metropolitan-Vickers Electrical Company, Ltd. A Brush set is expected towards May this year and an English Electric set is expected in 1956. All three sets were designed to the same specification in 1948. Together they will be able to develop the full pump load of the station, but they are primarily installed as emergency sets. Relief load to the main pumps is provided by three diesel sets of 1500kW each. All three gas turbines will be served by a common intake and exhaust ducting.

An illustration of the Metropolitan-Vickers 1500kW gas turbine set is reproduced in Fig. 1. Part of its kinematic mounting can be seen, together with the arrangement of six combustion cans which follows aeronautical practice. A simple open cycle is used having a single shaft rotating at 7000 r.p.m., driving an output shaft through reduction gearing at 1500 r.p.m. The turbine inlet temperature is 1250 deg. Fah.

The Brush set employs a constant-speed power turbine driving the alternator at 3000 r.p.m., the gas generator having a shaft speed of 6375 r.p.m. There are ten combustion chambers. With the English Electric set a free turbine is employed rotating at 6790 r.p.m. and driving the alternator through reduction gearing at 1500 r.p.m. The gas generator speed is 8220 r.p.m. It also employs a much different combustion system consisting of two chambers arranged with reverse flow. The design efficiency of all sets is about 18 per cent.

In May we were able to describe and illustrate the 200 h.p. emergency marine gas turbine which has been developed for the Admiralty by W. H. Allen, Sons and Co., Ltd. The distinguishing feature of this engine is the use of a centrifugal impeller and a radial turbine formed integrally on opposite faces of the rotor (Fig. 2). In a later set, however, of 350kW the company is constructing, a multi-stage axial turbine is being used.

Of the smallest range of gas turbines reference was made in April to the 60 h.p. unit introduced by the Rover Company, Ltd. It was illustrated driving a 400-gallon per minute fire pump in a portable pack weighing 200 lb. It is a simple fixed shaft unit with a rotor speed of 46,000 r.p.m. An integrally bladed " Nimonic " rotor is used, operating with a maximum gas temperature of 790 deg. Cent. The specific fuel consumption is 1·46 lb/b.h.p./hr and the specific weight 1·93 lb/b.h.p.

CONTINENTAL GAS TURBINES

The remainder of this review is concerned with the progress which has been made in the design, construction and operation of gas turbines by the principal companies on the Continent.

BROWN BOVERI AND CO., LTD., BADEN

We are informed by British Brown Boveri, Ltd., of 75, Victoria Street, London, S.W.1, that in the works of Brown Boveri and Co., of Baden, Switzerland, the design of industrial gas turbines driving alternators for the generation of electric power has continued along orthodox lines with emphasis on the embodiment of further simplification, compactness and increased reliability in service. In particular, the experience which has been gained in the operation of fifteen turbine-generator units, several of which now have running records well above 10,000 hours, has enabled the company to complete the design and to obtain orders for single-shaft units of 12,000kW. During the year under review, orders have been obtained for the supply of eight generator units, representing a total output of 97,700kW at the alternator terminals. The total number of gas turbine-driven generator sets supplied by Brown Boveri and Co. and now under construction in its Baden works, has risen to thirty-three sets, having a combined generating capacity of 284,600kW. This total does not, however, include the gas turbines which have been built by the firm for locomotives, or for the driving of industrial compressors, nor the many gas turbines which have been supplied by the company for installation in oil refineries as part of the Houdry oil cracking plants, some of which have now exceeded 100,000 running hours.

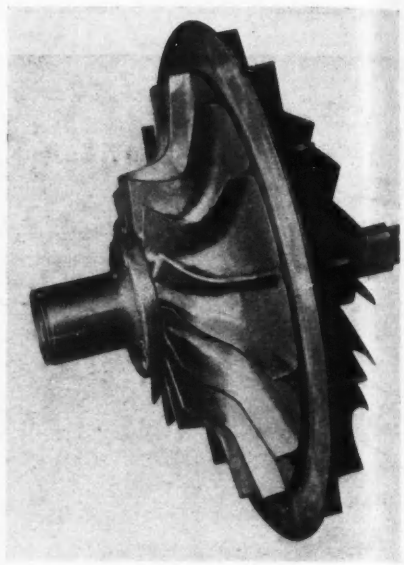


Fig. 2—Integral impeller and radial turbine rotor

It is interesting to note the wide distribution of these thirty-three sets. Eleven are for plants in Asia, ten in Europe, six in South America, three in North America, and three in Africa. Thirteen of these installations are designed to utilise natural gas, three work on blast-furnace gas, one on diesel fuel oil, and the remaining sixteen on heavy residual fuel oils.

The 40,000kW gas turbine winter load station of the Nordostschweizerischen Kraftwerk A.G. was fully described and illustrated in our last year's review, and it comprises two generating sets, one of 13,000kW and the other of 27,000kW capacity. This station, which is believed to be the largest gas turbine station in the world, exceeded in 1954 10,000 hours of operational duty, and up to November 31st it had generated a total of 291 million kWh. A still larger gas turbine-driven generator is now in course of design and construction in Baden works of Brown Boveri and Co. for Italy. Last year we made a short reference to the performance of the 5000kW single-shaft gas turbine set which was commissioned in 1953 at the Pertigalete power station of the Cia, A

Venexolana de Cementos in Venezuela. By October 17th this year, this set had been running 12,738 hours. Since the plant was started up, it has been in operation for 83 per cent of the total possible time, the average load recorded being about 4000kW.

In the accompanying illustration (Fig. 3) we show the 6000kW, 60-c/s Brown Boveri gas-turbine-driven generating set, of single-shaft design, which was recently commissioned at the Vermilion Power Plant, in Alberta, Canada. It is fired with natural gas and its rated output is 6000kW for an ambient air temperature of 25 deg. Cent., or 77 deg. Fah. With lower air temperatures, such as minus 20 deg. Cent (minus 4 deg. Fah.), which is the mean temperature during several weeks in the winter at Vermilion, the capacity increases and the set delivers continuously an output of 7500kW. The set has been in industrial operation since October, 1954.

GASTURBINE MAATSCHAPPIJ N.V., THE HAGUE, HOLLAND

We are informed by the Gasturbine Maatschappij N.V., of 22, Surinamestraat's Gravenhage, Holland (which represents the combined gas turbine interests of Werkspoor N.V., Amsterdam, Stork Brothers and Co., N.V., of Hengelo, the Royal De Schelde Company, of Flushing, the Rotterdam Dry Dock Company, of Rotterdam, and the Wilton-Fijenoord N.V., of Schiedam), that good progress has been recorded during the period under review. Following the tests made with the prototype gas turbine completed in 1952, and tested in a power station, work was begun on a 2000kW gas turbine generator set for the Bataafsche Petroleum Maatschappij for use in Venezuela. The first tests made with this new set were carried out in the later months of 1953 and the early months of 1954. In January, 1954, a continuous run under full load conditions was made for a period of fourteen days successfully. The efficiency recorded was about 16 per cent at the turbine coupling and the maximum temperature was 600 deg. Cent. This figure is slightly above the guaranteed performance. To meet the conditions under which the set will operate it was found necessary to provide a new rotor made of a more suitable material. This work is now approaching completion and, when ready, the turbine set will repeat the tests.

(To be continued.)

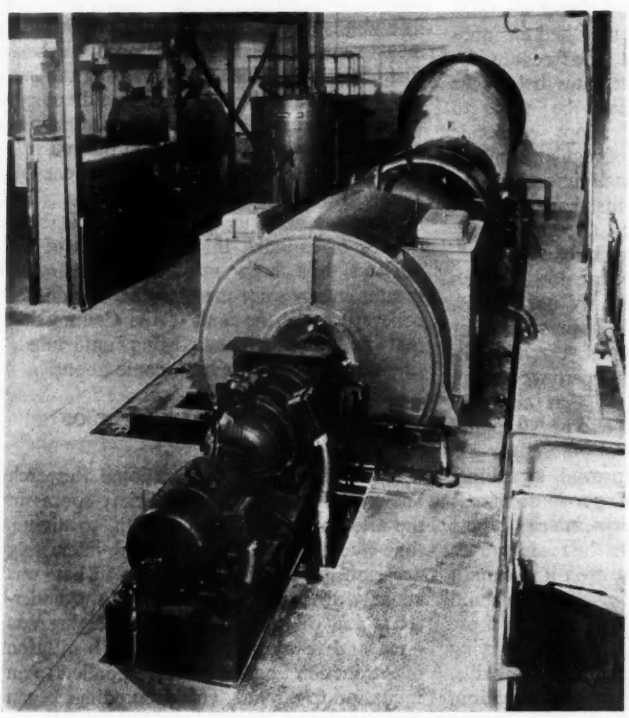
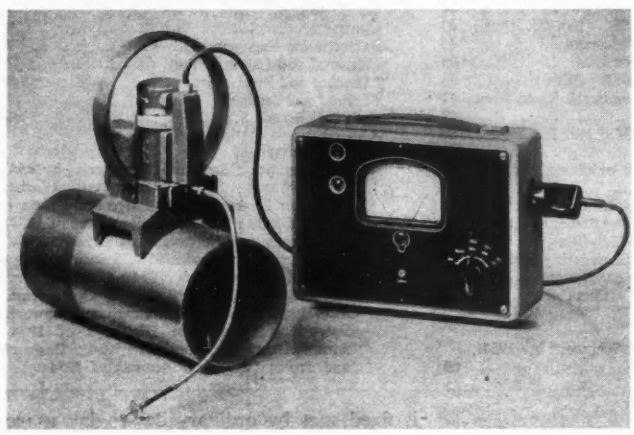


Fig. 3—6000kW gas-turbine-driven, 60 c/s set, installed at the Vermilion power plant in Alberta, Canada. It is driven with natural gas

Surface Roughness Tester

IN the accompanying illustration we show a portable roughness tester made by Ernst Leitz G.m.b.H., Wetzlar, Germany. In this instrument the surface irregularities of the test piece are traced by a small sapphire stylus, the movement of which is converted by a plunger coil into a variable e.m.f. This is amplified and indicated either as average surface roughness or R.M.S. value, a selector switch covering the total range of 0–50μ (average) in three stages.



Portable roughness tester resting on specimen under test. The sapphire stylus moves in a slide on the base of the instrument. On the right is the amplifier

The vee surfaces of the instrument base can accommodate flat test pieces or cylindrical ones from 30mm to 100mm diameter. On the base is mounted the stylus slide which has a stroke of 6mm and, during the test, moves under a spring - and - dashpot action at a constant speed of 0·6mm per second. With a lower frequency cut-off at 6 c/s, this sets an upper limit to the length of surface waviness which can be measured, of about 100μ, which can, however, be extended to 300μ by speeding up the slide. A wire release shown in the photograph serves to return the slide and to rewind the mechanism; during the return movement the stylus is lifted off the surface by applying a d.c. potential to the coil, and the indicator is switched off. The height of the sapphire point is adjustable, and a working load of about 1 gramme is used on a point of 15μ radius.

The instrument can also be supplied mounted on a universal stand, or on a stand specially equipped for series inspection of flat and round parts of up to 30mm diameter. An internal inspection attachment is available for hobs of 9mm diameter and over, and up to 35mm in length. The instrument is marketed in this country by E. Leitz Instruments, Ltd., 20, Mortimer Street, London, W.1.

Plate Shears for Straight or Bevel Cutting

A GUILLOTINE which can cut large plates, either "square" or at an angle up to 35 deg., is made by Eumuco Aktiengesellschaft fuer Maschinenbau, Leverkusen 1, Germany. The machine is being made in a number of sizes, the greatest cutting length in one stroke being 157½in and the greatest thickness of metal, for 28-ton steel, being $1^1/_{32}$in. A C-frame of welded construction is employed, which supports a turning device for varying the direction of stroke of the upper blade. This is done by changing the position of the fulcrum *A* of the top blade support, which can be moved along curved guides by an electrically driven turning gear (see illustration). The bottom position of *A* gives a square cut, while the top position gives a bevel cut, the actual setting being shown on a dial *B*. The position of the cutting line is indicated by lamps throwing the shadow of the movable blade on to the work. This shadow line is clearly visible and in this way errors due to parallax are avoided. Alternatively, the plate may be fed against a stop which can be adjusted from the operator's desk by means of an electric motor. Heavy spring-loaded plate holders are fitted, which hold the plate securely irrespective of its size or thickness. The cutting action is obtained from an eccentric shaft through gearing, the drive incorporating an electro-pneumatic single-disc clutch and brake. The blades are reversible and have four cutting edges. Upper and lower blades are similar and, after regrinding, the lower blade can be raised by means of a serrated wedge plate on which the blade support is resting. The safety devices include a trellis guard for the blade.

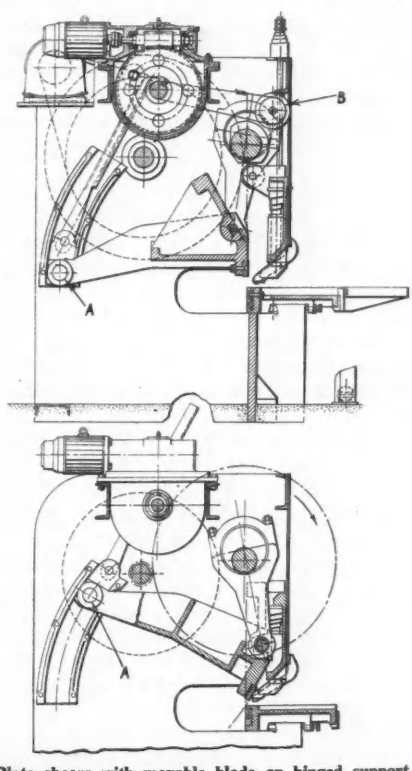


Plate shears with movable blade on hinged support. Fulcrum A in bottom position gives a square cut, when raised gives bevel cut up to 35 degrees, the setting being shown on dial B

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ECONOMIES AND WAGES ON THE RAILWAYS

By one of those strange coincidences with which life abounds there was presented before the Institute of Transport last Monday a paper that has particular relevance to that discussion of wage claims in nationalised industries which the Interim Report of the Court of Inquiry into the railway wage dispute precipitated. The paper was entitled "Economics of Intensified Use of Railway Operating and Motive Power Resources," and it was presented by Mr. H. H. Phillips, Assistant General Manager of the Western Region. The scope for improvement in the economics of railway operation was revealed by deriving from statistics such conclusions as that the period of locomotives in payload movement probably amounts to less than seven hours a day ; that drivers spend only about five hours a day actually on the footplate of an engine in traffic ; that wagons are carrying loads in train movement for as little as fifty-five minutes a day ; and that passenger train stock is attached to a train engine for not more than 4½ hours a day, the period of revenue earning movement being probably much smaller. Those rather startling figures are, of course, not in themselves evidence of inefficiency. They are average figures imposed upon the railways as a consequence of the habits of railway users. Locomotive usage and drivers' hours are heavily influenced by the requirements of timetables drawn up to accord with public demand. The low figure for revenue earning hours of wagons is partly a reflection of the habit of users of regarding wagons as convenient temporary storage receptacles. What, we wonder, would be the reaction of a road transport concern to a customer who proposed to retain motor vehicles over the week-end on the excuse that he had nowhere else to store their contents ! The quantity of passenger coaches required by the railways is fixed, not by ordinary day-to-day usage, but by inflated demands at holiday week-ends and, in the suburban sense, by rush-hour traffic. Yet that there is room to make economies, if only practicable means of realisation can be found, is effectively demonstrated by the figures. Indeed, Mr. Phillips showed that some economies can be and have been made without asking for new equipment. He showed also that larger economies would be possible as a consequence of modernisation.

There are, in addition, other important economies which the railways have now become free to achieve as a consequence of their relief from some of the restrictions imposed upon them when they had a monopoly of inland transport. The freedom, for example, to charge freight rates below the maximum will, no doubt, be used to encourage customers to adopt economic practices, such as the offer of regular numbers of full wagon loads at fixed intervals ; to discourage the offer of loads that could not be economically carried ; and to attract traffics likely to prove profitable. Action, too, may become easier to close down branch lines that cannot economically be worked. All-in-all, in fact, there is a prospect that within a reasonable number of years the railways may again become a prosperous concern, though the achievement of that end will require much re-equipment and heavy capital expenditure on electrification, diesel (or gas turbine) locomotives, improved signalling, and the reconstruction of goods terminals and shunting yards. But the interim report of the Court of Inquiry into the recent wages dispute has laid down that even if it cannot at present afford it, the Commission should still pay wages that accord in level with those paid in other industries to men carrying similar responsibilities or using similar skills. That seems a reasonable enough contention. But how are those rates of wages to be paid in the interim until modernisation becomes effective ? Furthermore, the dictum of the Court that "having willed the end the nation must will the means" may be held to contain some unpleasant implications. Within industries wholly controlled by private enterprise the claims of unions for higher pay are countered by employers' claims that higher wages cannot be afforded, that is, that the enforcement of an unreasonable wage claim must lead eventually to bankruptcies within the industry and consequently to unemployment. Is that bargaining weapon to be struck out of the hands of the boards of nationalised industries ?

The situation is rendered all the more ominous in that railways can hardly ever again expect to become in this country an expanding industry. The adoption of labour-saving methods and machines is comparatively simple in an expanding industry, because, though productivity per man will be rising, there is still no need to reduce the numbers employed. Even so there is often vigorous shop and sometimes also union resistance. But in a static or contracting industry it is far less simple. Union resistance is very likely to be encountered, and if it does not actually lead to the total rejection of schemes for economising labour, it may result in the retention of much redundant manpower. Should the Commission, and more particularly the railway unions ever come to believe that it is no longer necessary for the railways to pay their way, then it will become very difficult for the Commission to avoid yielding to the resistance even if it, and the union leaders, too, may recognise that the resistance is not really in the best interests of the men themselves. Modernisation might be delayed thereby or, if undertaken, be rendered economically ineffective. The meaning of the statutory requirement in certain nationalisation Acts that "taking one year with another" the accounts shall balance now needs clarifying ; and the clarification should come from the Government. For it seems to us undoubtedly the fault of post-war Governments that the existing situation has arisen. There has been much clamour over the last few years about the failure to spend enough nationally on road improvements. But, as we have repeatedly remarked in this journal, the real failure has been to spend enough money on land transport as a whole. The railways as well as the roads have been starved of capital. If modernisation of the railways had been pressed forward with greater energy since the war—and we do not believe it to be the fault of the Commission that it has not—the existing unfortunate situation might never have come about.

ACCURACY AND VALIDITY OF TIME-STUDY

A meeting of the Operational Research Society held at the Royal Society rooms in the afternoon of December 20th, to discuss time-study, proved to be an interesting occasion, not only because of what was actually discussed but because of the undertones and the omissions. The meeting was open and many members of the Institution of Production Engineers had responded to an invitation to attend. The proceedings began with the presentation of two papers by Mr. Winston Rodgers of the Department of

Scientific and Industrial Research, and Professor T. U. Matthew, of Birmingham University. These papers described experiments, independently carried out from start to finish, but similar in character, on what the speakers said was time-study; they dealt in fact, mainly with what is usually called "rating." In the rating system the time-study man takes one or more readings of the actual time for an operation, and then applies a multiplying factor to increase or decrease the observed time according to the rate at which he considers the operator to be working—slower than normal, normal, or faster than normal.

In both investigations experienced time-study observers were drawn as volunteers from a number of industries, and in both cases great care was taken to avoid bias. For instance, observers from the same firm were assigned different observed tasks. In both cases, too, the experiments were carefully planned for subsequent statistical analysis, with trained statisticians as members of the team which dealt with the results. Results were somewhat similar. Conclusions were that rating does vary from time to time for a single trained time-study man and that rating varies as between time-study men. In one of the studies the figure of 3 per cent "within a single observer" was given and "9 per cent between two observers from the same company." Both speakers made it abundantly clear that the purpose of the experiments was to examine the extent of the variability which is known to exist, and then to proceed to further experiments, the result of which may be to reduce this variability and improve the accuracy of time-study rating. Professor Matthew alluded to, but did not describe, a method which has been evolved as a sequel to the studies which it is claimed does help to standardise time-study rating.

The discussion which followed the reading of the papers was constructive and good-tempered. There were those who thought that time-study with rating as practised at present is accurate enough, and this delving into whys and wherefores was a little unseemly. But there were none who claimed, as used to be done, that men can be trained to rate absolutely accurately. That seems to be a sign of a move forward in thinking. The general consensus of opinion was that these studies, and others of a similar character being carried out in Belgium, France, Germany and the U.S.A., agree, and that the sensible thing to do now is to accept the findings and endeavour to reduce the components that build up variability, such as differences of training within an organisation, between organisations in a district, between districts, &c., and by standardisation of training, of rating scales, and so forth, under some central body, such as, for instance, the Institution of Production Engineers. At one point in the discussion the question was raised as to whether the experiments described had really dealt with absolute accuracy, or with consistency, or merely with acceptability. How does one know that an actual average time, or accepted normal rating does represent a fair day's work? Is it not true that such standards may vary from district to district and from country to country? Does it not sometimes happen that a certain set of people appear to be content with a definite upper limit of income, and time-studies and rating and bonus or piece rates have to be made with this fact in mind? Those questions point the way to further studies.

Obituary

ENGINEER REAR ADMIRAL A. TURNER

IT is with regret that we record the death of Engineer Rear Admiral Alfred Turner, which occurred on Wednesday of last week, at his home in Southampton. Alfred Turner, who retired from the Navy in 1932 with the rank of Rear Admiral, was born on July 6, 1880, and was educated at Scarborough Grammar School, and later at a school in Portsmouth. He studied at Keyham for five years and completed his training there in 1902, and most of his career was spent on the staff of the Engineer-in-Chief, where he was engaged on the design and construction of machinery for battleships and battle cruisers. For a period during the first world war he was engineer officer of the destroyer "Musketeer" and later of the minelayer "Abdiel." On returning to shore duties in 1918, he turned his attention to the development of the internal combustion engine. It was in that year that he was promoted to Engineer Commander; eight years later he became Engineer Captain, a rank which he held until his retirement. Admiral Turner was recalled for service at the beginning of the second world war as Emergency Repair Overseer in the Thames district, and then for a short period from 1941 to 1942 was at the Naval Dockyard at Sheerness, after which he returned to the Thames area as Principal Repair Overseer, a position he continued to occupy until 1946.

Literature

Comprehensive Guide to Factory Law. By ROBERT MCKOWN. London: Chantry Publications, Ltd., 63, Neal Street, Shaftesbury Avenue, W.C.2. Price 21s.

EVERY occupier of a factory knows but too well that in the conduct of his business he has to comply, not only with the provisions of the Factories Acts, but with countless rules and regulations made thereunder. But that is not all. There are many Acts of Parliament, e.g. the Petroleum Act, the Explosives Act, and the Food and Drugs Acts, some of the provisions of which have to be observed in factories. In these circumstances, it is essential that there shall be "in the office" some volume to which those who have to supervise the work can have recourse; and it should, by preference, be in a compendious form and so indexed that the rules, &c., relating to any particular process and machine can be found without undue loss of time. In this book, Mr. McKown has set forth all the legal requirements affecting safety, health, welfare, hours of work and administrative matters. They are classified and indexed according to subject, irrespective of the particular legal setting in which they appear. It is thus simple to find what the law requires in respect of any particular operation, type of plant, &c. Questions may arise, of course, which require for their solution very careful consideration of the precise words of some statute or rule; may even necessitate reference to some case decided by one of Her Majesty's Judges. But such legal problems are best referred to "the company's lawyers."

That the observance of factory regulations is something of moment is proved by the fact that nearly every number of the weekly *Law Reports* contains a report of some case in which a claim has been made—and often with success—for heavy damages. For one case reported, there are many heard and decided without much publicity; and for every case which actually gets into court there are many others which are settled—generally to the advantage of the plaintiff. Knowing this, the author of the work before us has dwelt (in Chapter XIV) on the "Safety Precautions Required by Common Law." In the course of a few pages he gives his reader a very admirable summary—taking care, at the outset, to emphasise the fact that, wholly apart from the Factory Acts, an employer is under a duty at common law to take precautions against danger to his workman. Failure to do this may involve a claim for damages. Such a claim, if brought into court, may result in a judgment for a large sum; and, as owners of factories may have noticed not without some alarm, the tendency of our judges when assessing damages is always upwards.

This kind of generosity is the more remarkable when it is remembered that nearly every man who is injured in a factory accident can (and, we suppose, does) make a claim for benefit under the Act which took the place of the old Workmen's Compensation Act. When assessing damages, a judge is bound to take that matter into account. But one can never discover from a consideration of the report of an accident case how much has been deducted on this account.

And there is this further point: the injured workman who is suing a factory owner for damages is "playing on a good wicket." In the first place, if he can show that there has been a breach, however trifling, of some provision of the Factory Acts, or the rules made thereunder, negligence on the part of the employer need not be proved; it is presumed by the court. In the second place (as matters now stand) a workman can usually get "legal aid" on the assertion of his claim. That means that his liability for his own costs is reduced to a minimum, and that he will very seldom or never be called upon the costs of the "other side" whatever the result of the action. The fact that a "breach of the rules" may lead not only to a prosecution but to all the vexation and expense attendant upon an action at law, should encourage the occupier of a factory to have Mr. McKown's book within easy reach.

Cost Accounting and the Engineer. By KENNETH B. MITCHELL. London: Iliffe and Sons, Ltd., Dorset House, Stamford Street, S.E.1. Price 10s. 6d.

ON opening this book we find the heading of the first chapter reads: "Is Cost Accounting Necessary?" and we wonder whether such a question as this has not been answered in the affirmative many years ago. When, however, we are told that 75 per cent of British industrial establishments have less than 100 employees, we realise that perhaps a number of these smaller undertakings still fail to appreciate the benefits that can result from a good system of cost accounting. With a view to their conversion we commend a study of *Cost Accounting and the Engineer*, for the subject is presented in a straightforward and simple manner. Harm has undoubtedly been done in the past by a newly appointed cost accountant assuming a dictatorial manner rather than taking the position of

a handmaid ready to serve the management by the presentation of facts that will help to show where action should be taken in the interests of efficiency. For this reason we should have liked to be told what position in the factory hierarchy Mr. Mitchell would assign to his cost accountant, or, in other words, who is his opposite number in the factory management.

The first part of this book stresses the necessity for accurate cost keeping if it is to be of real value to a manager, and then proceeds to describe the general principles involved, next developing the methods of accounting for material, labour and factory expense. The various methods of applying the overhead expenses to production, and the way in which the final cost is arrived at, and its presentation to the management are clearly and simply explained. The general practice for determining the selling price to be applied, and also the influence of fixed and variable costs are systematically described. Up to this point the author has occupied his reader with what has been termed " historical " costs, but he now points out the disadvantages, explaining how the practice of " standard " costs has been evolved. Here, however, he might well draw attention to some of the difficulties likely to be encountered in applying standard costs to small firms engaged in a diversity of products.

The second part of the book is concerned with budgeting and budgetary control, a subject that is increasingly finding favour, its importance being evidenced by the fact that over a third of the book is devoted to it. The purpose of the budget is explained, and how it is determined ; the material budget, the labour budget, and the expense budget also are reviewed and how the latter is calculated is shown. Finally the administrative and master budgets are dealt with, and the reader is shown how budgetary control is applied.

There are many points on which we should have welcomed Mr. Mitchell's opinion. Would he place the cost accountant under the company financial accountant ? Reading between the lines, we think he would do so, although he definitely states very succinctly that financial accounts are responsible for all external accounts, and cost accounts for the internal. For this very reason we suggest that they should be under different heads, but the two accounts should be effectively interlocked, not " reconciled," as some are too prone to say, indeed we regret to notice that the author himself uses the word " reconciliation " (page 54). We agree with the suggestion that the machine-hour rate is one of the best means of accurately recovering overhead expense when an engineering works is functioning normally, but it can have a very prejudicial effect if estimators follow it slavishly in times of slump. We should like to see this safeguarded. Indeed, we would go further and welcome attention being taken to show how good cost accounting can help in the preparation of good estimates. Without doubt the closest liaison should be maintained between these two departments. When payment by results is being examined we are rather surprised to read that " timings have been based on the fastest worker," for generally speaking, they are, and should be, based on the speed of the average worker. For this reason the practice has been dropped of a rate fixer giving a practical demonstration that his price is fair. He may have been selected for the post on account of his skill as a mechanic; nevertheless there is also the danger of failure in his demonstration on account of his being so long away from his tools.

Mr. Mitchell handles the important subject of the budget in a manner calculated to interest the engineer, so that the latter should not regard it as purely theoretical, but will soon realise that " when difficult situations exist the extra value of the budget is seen, in that it suggests immediately where corrective action may be taken." The necessity of all levels of members of the company fully co-operating is essential and it is refreshing to read that the author favours the compilation of the budget being made by the management staff, with the ready assistance of the cost accountant. This should certainly tend to make the manager think of it as an engineer's budget. Whether the budget should be prepared annually, quarterly or monthly is a matter of opinion, but if the month be decided on, it is well worth considering a year of thirteen accounting periods of twenty-eight days each, thereby rendering comparison month by month more helpful.

This book is in no way a textbook of cost accounting—there are many of these in existence—but it is an honest endeavour to interest manager and engineer alike in a very important subject, and to this end it will serve a very useful purpose.

In conclusion perhaps a note of warning should be sounded. When a manager realises how useful to him are the facts brought to light by the cost accountant he is likely to become enthusiastic and ask for more and more detailed information, yet hardly appreciating the extra work involved with its consequential additional cost. He will have to train himself to consider seriously whether he is justified in asking for so much detail. It might be well for Mr. Mitchell to consider covering this important point in future editions of a valuable work.

Conference on the North Sea Floods of January 31/*February* 1, 1953. London : Institution of Civil Engineers, Great George Street, S.W.1. Price 25s.

THE papers presented at the Institution of Civil Engineers' conference held in December 1953, have now been published, together with the discussions and authors' replies, in this volume. THE ENGINEER has from time to time given rather complete accounts of the sea defence works occasioned by the 1953 floods, both in this country and in Holland, and has commented on the conference and on the Waverley Report. There is, therefore, little more that can be said now. The papers and discussions give a comprehensive account of the technical problems of coast protection, and, as the Institution points out, form a complement to the Waverley Report. The present state of the art of coast protection, as revealed by these papers, can perhaps be very briefly summed up by quoting from one of the authors of the papers, who noted that his intention had been to " sketch an outline of a subject fundamentally bedevilled by lack of basic data."

Letter to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

JAMES BRINDLEY

SIR,—On a dilapidated altar-tomb in the churchyard of St. James's, Newchapel, Stoke-on-Trent, Staffordshire, is the following inscription : " In memory of James Brindley of Turnhurst, Engineer, who was interred here Sept. 30th, 1772, aged 56."

James Brindley was my great-great-grandmother's first husband, and I am writing this letter in the hope that it may be read by people who appreciate the importance of James Brindley's work in the early years of the canal era, and who may wish to help the Vicar of St. James's, Newchapel, to raise the £300 needed for the repair of this tomb and the contiguous line of four tombs of James Brindley's relations forming the immediate approach to it.

W. CORBETT WILLIAMSON

Malvern Link,
Worcestershire,
January 5th.

Short Notices

Gauge Making and Measuring. London : Her Majesty's Stationery Office, York House, Kingsway, W.C.2. Price 3s.—This is the fifth publication in the series " Notes on Applied Science," published by the National Physical Laboratory, and it is intended to make available to gauge makers comprehensive and detailed information on the subject. An introductory section deals with the general principles of the subject, including the general requirements in gauging technique, measurement in the workshop and the care of measuring tools. The remainder of the book is divided into three parts dealing with gauge making, general measuring apparatus and special apparatus and methods of measurement. Only the simpler kinds of plain and form gauges are dealt with, screw gauges having been the subject of an earlier publication in the series.

The part dealing with gauge making covers the selection of materials, machining, hardening and grinding, both from a theoretical and a practical angle. The section covering general measuring equipment deals with all the measuring devices likely to be encountered in general engineering practice, including gauges, micrometers, comparators and optical measuring instruments. In the final section ring, gap, taper and other special gauges, including profile gauges, are described in detail. Useful appendices include tables for use in taper measurement and a bibliography covering the various fields of metrology.

Equilibres Physico-Chimiques et Données Thermodynamiques des Mélanges Gazeux aux Températures Elevées. By G. Ribaud and N. Manson. Publications Scientifiques et Techniques du Ministere de l'Air, No. 294, 1954. Obtainable from Majasin C.T.O., 2, Avenue de la Porte-D'Issy, Paris, 15e, France. Price 1200f. This book is the companion volume to No. 266 of the P.S.T. series, *Constantes Thermodynamiques des gaz aux Températures Elevées*, and deals with the calculation of thermodynamic quantities of gas mixtures at high temperatures and under conditions of equilibrium. After recapitulating the method given in the previous treatise for the calculation of equilibrium constants, the authors deal with the combustion of hydrocarbons and the effects of dissociation. Values of total heat, internal energy and entropy of combustion gases are tabulated for various temperatures and pressures, and it is shown how by their use various classical thermodynamical diagrams can quickly be set out.

Books Received

Surveying and Levelling for Students. By B. H. Knight. London : Contractors' Record, Ltd., Lennox House, Norfolk Street, Strand, W.C.2. Price 18s.

The History of Kirkstall Forge Through Seven Centuries, A.D.1200-1954 Second edition. York : William Sessions, Ltd., The Ebor Press, York. Price 63s.

The Design of Cylindrical Shell Roofs. By J. E. Gibson and D. W. Cooper. London : E. and F. N. Spon, Ltd., 15, Bedford Street, Strand, W.C.2. Price 35s.

The Inventor of the Valve : A Biography of Sir Ambrose Fleming. By J. T. MacGregor-Morris. London : The Television Society, 164, Shaftesbury Avenue, W.C.2. Price 10s.

Compressed Air Handbook. Second edition. Published by the Compressed Air and Gas Institute of America. London : McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 57s. 6d.

Electrical Engineering in 1954

No. II—(*Continued from page 27, January 7th*)

Railway Electrification

ELECTRICALLY hauled passenger services between Manchester and Sheffield were formally inaugurated by Sir Brian Robertson, chairman of the British Transport Commission, on September 14, 1954. It was a historic event in that it marked the completion of the first main-line electrification for both passenger and freight services in Great Britain. We may recall that the first stage of the scheme was completed on February 4, 1952, when the Wath-Penistone-Dunford Bridge section of 19 route miles was opened for electrically-operated coal and freight trains. The next stage involved the Woodhead new tunnel and the line to Manchester (London Road); it was opened for passenger and freight services on June 14, 1954. Completion of the third stage, to Sheffield (Victoria) brought the total route mileage electrified at 1500V d.c. to 68 miles. The service is operated by fifty-eight B_0–B_0 locomotives for mixed traffic working and seven C_0–C_0 locomotives* (as illustrated) for passenger working. The cost of the electrification itself was £10,955,000 and that of the Woodhead new tunnel was £2,800,000. Details of the scheme have been given in earlier articles (THE ENGINEER, February 8 to 22, 1952, April 23 and September 17, 1954).

No further reference to the subject is called for here except to recapitulate, as far as possible, the benefits that have accrued from this new electrification. The second and third stages are clearly too young to be evaluated yet. But the first stage has provided nearly three years of experience with the operation of goods and freight trains over a difficult section of line, and the following comparison of train timings† is interesting. For example, the timings of mineral trains between Wath and Mottram have been reduced from 191 min to 101 min and between Woodburn Junction pass and Mottram yard, from 160 min to 87 min. Express goods timings have been reduced from 86 min to 72 min between Sheffield (Bridgehouses) and Manchester (Ducie Street), and from 87 min to 69 min between Ardwick East and Sheffield (Bridgehouses). Through express passenger trains are timed to run between Sheffield (Victoria) and Manchester (London Road) in either direction in 56 min, which is 9 min less than by steam traction. There is a 5 min saving in the timing of trains which provide a half-hourly service from 5.15 a.m. to 7.45 a.m., and then an hourly service until 10.45 p.m., on the Manchester-Glossop suburban system. Finally, the timing for coal empties from Dewsnap yard to Wath has been reduced from 210 min to 99 min. Although these improvements are impressive, the full possibilities of the electrification cannot be exploited, nor can the gains be assessed, until sufficient operating experience has been obtained from the second and third stages of the conversion, including the last few miles to Rotherwood, due for completion this month.

The Manchester–Sheffield–Wath electrification is interesting as a modest indication of what might be attained by a major electrification programme. Just such a programme is being undertaken in France by the S.N.C.F. as part of a long-term policy. Implementation of this policy since 1900 has already led to the electrification of 2800 miles of line, including the main lines between Paris and Lyon, Paris and Hendaye, Paris, Toulouse and Nimes and Paris and Le Mans, which carry 30 per cent of the country's rail traffic. The new programme involves the electrification, in stages, of the main line from Lille to Thionville, Metz, Strasbourg and Bâle. This line carries the heaviest freight traffic on French Railways, made up mainly of iron ore trains from Lorraine, and of coal, coke and limestone. Electrification is to be at 25kV, 50 c/s, single-phase, a system which has enabled substantial economies to be effected in the capital cost of fixed equipment and has given satisfactory results in the Annecy region, where it has been on trial since 1950.

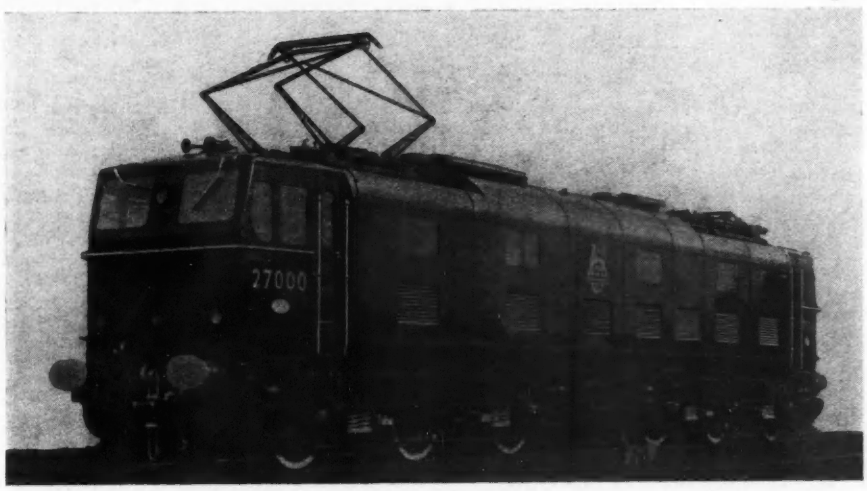
Work on the first stage of the electrification between Mézières, Charleville and Thionville is due to be completed by the end of this year, and the remaining sections (Lille–Valenciennes and Thionville–Reding–Strasbourg–Bâle) are due to be completed by 1957. Good progress has been made on the first stage and, in July, 1954, trials were started with three prototype locomotives, on the 109-mile section of line between Valenciennes and Charleville, which is characterised by several long gradients of the order of 1 : 100.

Two of these locomotives are 80-ton (metric) B_0–B_0 mixed traffic locomotives built by the Société le Matériel de Traction Electrique (Schneider, Jeumont, S.W.). One (BB 13001), is driven by four single-phase Jeumont traction motors giving it a continuous rating of 2720 h.p. at 33 m.p.h. The motors are unorthodox, in that there are no compensating windings and the interpoles are shunted by a system of capacitors. This locomotive, which is the first of a series of twenty-four under construction, was delivered on July 17th and by October 25th it had covered 39,000 miles (an average daily run of 380 miles), hauling trains with an average weight of 660 metric tons and a maximum weight of 900 tons.

The second B_0–B_0 locomotive (BB 12001) also weighs 80 metric tons, but is driven by four d.c. motors, each fed through two ignitrons, giving a continuous rating of 3260 h.p. at 33·5 m.p.h. The motors are in parallel and are operated by voltage control effected by a voltage regulator with a twenty-notch controller. Water cooling is used for the ignitrons, each of which has a guaranteed continuous rating of 475A at 750V. Fourteen of these locomotives have been ordered, and the prototype, which was delivered on July 17th, had run 38,400 miles (with a daily average of 384 miles) by October 25th, hauling trains with an average weight of 725 metric tons. A starting tractive effort of 1400 metric tons on a gradient of 1 : 100 has been achieved.

The third prototype was a C_0–C_0 locomotive (Plate 7 between pages 50 and 51), weighing 120 metric tons, designed and built by Alsthom, with a continuous rating of 3590 h.p. at 24 m.p.h., to haul very heavy freight trains. It is driven by six three-phase squirrel-cage traction motors which are supplied at variable voltage (and frequency) from single-phase/three-phase converters. The motive power unit consists of a synchronous motor, a six-pole rotary phase converter running at 1000 r.p.m., and an eight-pole frequency converter set with a speed ranging from −750 r.p.m. to +1280 r.p.m. This equipment transforms 50 c/s single-phase current into three-phase current, with a frequency range of 0 to 135 c/s and a voltage continuously variable between 0 and 1300V. The first set consists of a phase converter and d.c. generator on a common shaft; the second set consists of a frequency converter coupled to a d.c. motor. The generator supplies the d.c. motor with a variable voltage and thereby provides a means of varying the rotor speed of the frequency converter. The six three-phase squirrel-cage motors are supplied at variable frequency from the frequency converter.

This locomotive, the prototype of a series of 102, was delivered on July 29th and by October 25th it had covered 28,500 miles (a daily average of 320 miles), hauling trains with an average weight of 1360 tons and a maximum of 1800 tons. Several starting tests have been made on rising gradients and the locomotive has established its ability to start against a load of 2040 metric tons on a gradient of 1 : 100. Deliveries of locomotives based on these three prototypes are now



C_0-C_0 locomotive for Manchester - Sheffield electrification. It is one of seven locomotives intended mainly for passenger service but suitable for mixed traffic. Each axle is gear driven by a 415 h.p. motor, the maximum speed is 90 m.p.h. and regenerative braking is incorporated

* THE ENGINEER, April 23, 1954.

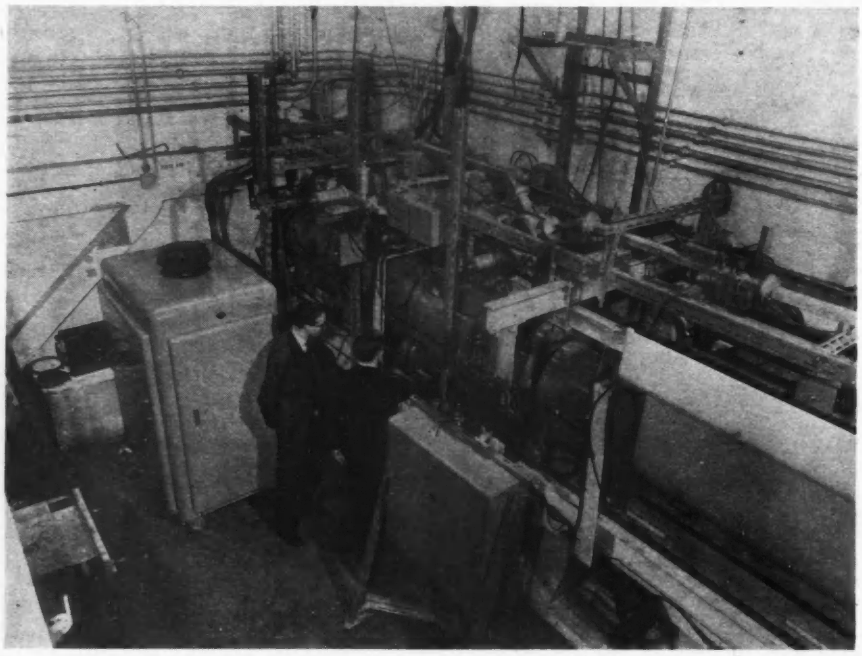
† "Electrification of the Manchester, Sheffield and Wath Lines," published by London Midland Region, British Railways

being made at the rate of about seven or eight a month. In addition, a further series of twenty goods locomotives is on order from the Oerlikon Engineering Company.

Apart from the Manchester-Sheffield scheme there were no main line electrification works in progress in Britain in 1954 and most of the output of British electric locomotives went abroad. Two examples are illustrated in Plate 7.

Equipment for Radiotherapy

Some interesting developments in equipment for radiotherapy were recorded in 1954. In September, for example, a 15MeV travelling wave linear accelerator was completed by Mullard, Ltd., and it was installed in the physics department of St. Bartholomew's Hospital College, London. This machine is being used, for the first few years, for research work on the action of radiation on living tissue and on the best methods of the treatment of cancer. Ultimately, having determined the suitability of this kind of treatment and established the requisite techniques, it is expected that the equipment will be used for the treatment of patients.



15MeV linear accelerator for radiotherapy. This equipment, here seen under construction at Mullard Research Laboratories, is now installed for research work in the physics department of St. Bartholomew's Hospital, London

Basically the 15MeV linear accelerator is a source of high-energy electrons, which can be used for medical research and treatment in three main ways. First, the electrons can be made to strike a metal plate producing high-energy X-rays which are suitable for the treatment of deep-seated tumours. Secondly, the accelerator is so designed that the beam of 15MeV electrons can be used directly for treatment; the effectiveness of this method of attacking certain kinds of tumours has recently been demonstrated. Finally, the accelerator may be used to produce fast neutrons by directing the electrons on to a uranium target; but the effects of this treatment on living tissue have yet to be investigated.

In the 15MeV accelerator, short bursts of electrons are projected from a high-voltage electron gun at a velocity of 0·4 times the speed of light into an evacuated hollow high-frequency transmission line or "corrugated waveguide." Electrical energy in the form of 10cm radio waves is fed into this waveguide from a magnetron in such a way that the electrons are accelerated by the electric field produced by the waves.

Near the remote end of the waveguide the electrons travel at very nearly the speed of light. On emerging from the waveguide the electrons are subjected to a magnetic field which bends them through 90 deg. when they impinge on X-ray or neutron targets or are allowed to pass out directly to strike an outside target.

An important part of the accelerator, which enables its length to be kept small is a "feedback bridge," by means of which the unused energy is fed back into the waveguide in such a way as to supplement the radio waves generated by the magnetron, so increasing the accelerating power of the guide. Energy is delivered to the magnetron from a modulator which produces output pulses of up to 5MW (peak) and of 2 microseconds duration at a rate of up to 500 pulses per second. For ease of treatment the X-ray head is rotatable by means of a motor through an arc of 150 deg. By selecting the directions of the beam and suitably positioning the patient the necessary doses can be administered without excessive damage.

The corrugated waveguide down which the electrons are projected is made up of six 1m sections, mounted on trollies for ease of assembly. The first four are mounted on a concrete bench and the trollies of the two final 1m lengths are slung from overhead rails to leave a clear space under the machine for the accommodation of patients.

Each 1m section of waveguide is made up of a number of circular cells of about 1cm in thickness. The cells are initially shallow cup pressings made from copper strip 5in wide and 0·25in thick. The finished cells, which are machined to a tolerance of three ten-thousandths of an inch at 20 deg. Cent., are soldered together by a special process to form the 1m sections. The accelerator is assembled in two 3m sections (built up from 1m sections) joined by a central member which carries an oil diffusion pump for evacuating the system. The whole of the accelerator and its associated waveguide up to the magnetron window are evacuated by the pump to a pressure of about three millionths of a millimetre of mercury. A special vacuum-tight rotating joint permits the X-ray head to be rotated. At the input end of the accelerator a vacuum valve is provided on the electron gun so that the cathode can be replaced if necessary without letting air into the main vacuum system.

Comprehensive control facilities are provided to allow the accelerator to be used for experimental work but, for clinical use, the equipment can be operated by a radiographer using a few controls on a desk-mounted panel. Our illustration shows the linear accelerator during construction at the Mullard research laboratories.

Advanced equipment for radiotherapy has also been installed at a number of other hospitals in Great Britain. The installation at the Christie Hospital and Holt Radium Institute, Manchester, is of special interest. It includes a 4MeV travelling wave linear accelerator and a 20MeV betratron, both of which were made by Metropolitan-Vickers Electrical Company, Ltd., as described in our issue of November 19, 1954 (pages 700–702). The 4MeV linear accelerator is the first of a family of equipments known as "Orthotrons": the second is being installed at the Western General Hospital, Edinburgh, and the third at the Mount Vernon Hospital, Northwood.

When operated at 4MeV each of these "Orthotrons" can produce an unfiltered X-ray beam output of 330 röntgens per minute at 1m from the X-ray target. The insertion of a suitable filter to give a uniform beam with the diaphragms fully open reduces the maximum output to about 200 röntgens per minute. In practice it has been found that a convenient treatment rate is about 100 röntgens per minute, allowing the equipment to be operated well within its limits, with an increase in the useful life of some of the more important valves.

The 20MeV betratron is the only equipment of its kind used for clinical purposes in this country, and it will be used, initially, on an experimental basis. In the betratron, electrons are injected at 60kV from a small electron gun into an evacuated glass toroid which is mounted between the shaped pole pieces of a large a.c. electro-magnet. As the magnetic field increases sinusoidally the electrons are accelerated around the toroid, gaining 80 electron volts in each revolution. After 1/600th of a second the electrons reach their maximum energy, whereupon the orbit is expanded so that the electrons spiral outwards and strike a small platinum target attached to the end of the electron gun. The X-rays are produced in the forward direction in a narrow cone as a series of two-microsecond pulses, 500 times per second. Before the insertion of compensating filters the X-ray yield of the betratron at 1m from the target is 100 röntgens per minute, as measured by a condenser thimble surrounded by 6cm of polystyrene.

The magnet, which weighs 7½ tons, can be rotated through 120 deg. so that the X-ray beam can be set at any direction from 15 deg. above the horizontal to 15 deg. beyond the vertical. The magnet framework can be raised or lowered by motor-driven screws through a distance of 7ft.

High-Voltage Cables

On March 25, 1954, the British Electricity Authority inaugurated a testing site at Staythorpe (Notts) power station, where 275kV cables will be tested under service conditions for about two years. Three

British cable makers (British Insulated Callender's Cables, Ltd., Enfield Cables, Ltd., and Pirelli-General Cable Works, Ltd.) have submitted 100-yard test loops of single-core 275kV cables, together with straight joints and sealing ends, to undergo intensive field trials. Although the nominal voltage of the cables will be 275kV, they may be required to work continuously at 300kV and should be able to pass an impulse test of 1050kV. The test lengths are connected in series with one phase of the 275kV overhead line which links Staythorpe and West Melton. On the site isolating switches are provided so that any of the cables can be switched in or out of circuit as necessary. While the cables are on test the surges to which they are subjected will be measured by a surge recorder. Measurements of sheath temperature will be taken to ascertain the maximum temperature of the conductors during load cycles, and records will be kept of the voltage and load on the overhead line.

Two lengths of cable are being supplied by British Insulated Callender's Cables, Ltd. —a 275kV impregnated pressure cable and a 275kV oil-filled cable. The impregnated pressure cable is designed to operate at a maximum stress at the conductor of 110kV/cm, under a nitrogen pressure of 200 lb per square inch. As the overhead line to which the cable will be connected is only lightly loaded, a special conductor arrangement has been adopted so that the conductor will attain a temperature of 80 deg. Cent., the maximum designed temperature for such cables operating under full-load conditions. In all other respects the cable will be similar to those offered for commercial use. The conductor arrangement consists of a stranded centre made up of 61/0·083in aluminium wires, covered with a paper separator, over which is stranded a single layer of 47/0·066in aluminium wires which will actually carry the current, giving an effective conductor area of 0·16 square inch. This conductor is screened with metallised paper tapes over which the paper insulation is applied. The lead alloy sheath is reinforced with tin-bronze strips applied both longitudinally and circumferentially, and an anti-corrosive protection of p.v.c., rubber and hessian is applied overall. The final overall diameter of the cable is 3·87in.

The B.I.C.C. 275kV oil-filled cable has also been designed to operate at a maximum stress at the conductor of 110kV/cm. It consists of a 16mm oil duct round which is formed the conductor, comprising 111/0·074in tin-bronze wires giving a conductor area of 0·46 square inch. To ensure the conductor would attain a temperature of 80 deg. Cent. tin-bronze wires were used, giving an increased resistance and consequent temperature rise. The conductor is screened with metallised paper tapes, and over the paper insulation is applied a metallic screen and a copper-woven fabric tape. The lead sheath is 0·115in thick, giving the cable a diameter of 3·43in. The reinforcement comprises tin-bronze strips and an anti-corrosive protection of p.v.c. rubber and hessian is applied overall. The final overall diameter of the cable is 3·64in.

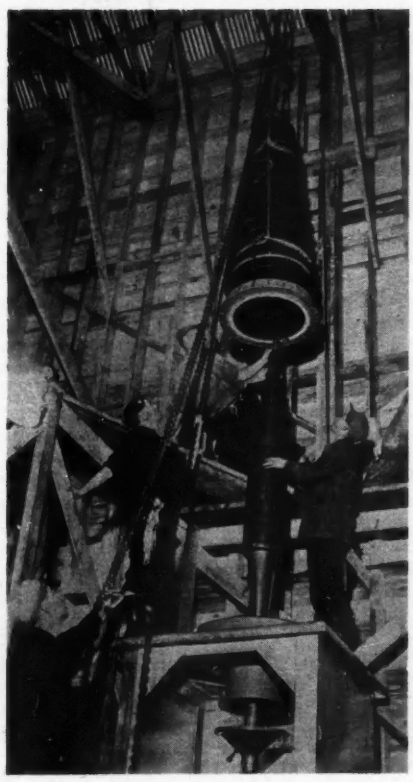
The installation includes an impregnated pressure straight joint of new design. Electrically it is similar to the lower voltage impregnated pressure cables, but the cast plumbs have been replaced by a mechanical sealing arrangement and the inner lead sleeve has been omitted. The conductors are joined by a soldered flush-fitting ferrule, the overall diameter of the ferrule being equal to the diameter of the conductor. The impregnated pressure cable sealing ends consist of a condenser cone arrangement housed in anti-fog porcelains capable of withstanding the internal pressure of 200 lb per square inch. The condenser cone arrangement permits the use of a relatively small diameter of porcelain.

The straight joint and sealing ends for the oil-filled cable were specially designed for this installation, the sealing ends using the same kind of porcelains as the impregnated pressure cable sealing ends.

The cable submitted by Enfield Cables, Ltd., is the outcome of considerable experience gained with 220kV self-contained compression cables installed at the Fontenay Testing Centre of the Electricité de France, and with an experimental cable which had been tested for many years in the company's high-voltage laboratory at Brimsdown. The cable has an oval conductor of 0·4 square inch, screened with carbon paper, and is designed to withstand a maximum stress of 150kV/cm under a nominal gas pressure of 250 lb per square inch. The dielectric thickness is 0·8in, the nominal loading is 200MVA and actual loading 120MVA. With an overall diameter of 3·7in the cable weighs 16 lb per single core foot, and a sample of it has withstood the standard impulse test of 1050kV peak. Since installation, the cable has been successfully subjected to a d.c. test voltage of 550kV for fifteen minutes. The construction of the cable and joint follows the usual design for self-contained compression cables and the cable is terminated in double-shed, anti-fog pressure porcelain sealing ends. To comply with the electrical tests at the site, prefabricated condenser cones manufactured by Standard Telephones and Cables, Ltd., were used to terminate the cable inside the porcelains. The normal compensator unit, gas filling valves and gas pressure gauges are installed.

The cable submitted by Pirelli-General Cable Works, Ltd., is an oil-filled 275kV cable. To match the overhead line, a prototype cable having a conductor size of 0·4 square inch was required, but, since the transformers at present available will not fully load a cable of this size, a conductor of 70/30 brass wire was used. This enabled a cable to be designed having the necessary electrical and mechanical characteristics to meet the trial installation conditions with negligible change in conductor and insulation from the standard 0·4 square inch cable. The conductor is screened and lapped with paper tapes, giving a dielectric of graded construction which is externally screened with metallised paper and is single-lead-sheathed. The lead-alloy sheath is reinforced with bronze tapes and protected overall with an anti-corrosive serving. The final overall diameter is 3·18in. The straight joint and two sealing ends which form part of the Pirelli-General installation have been designed in the light of experienced gained with the 301kV cables made recently for the Kemano-Kitimat project of the Aluminum Company of Canada, Ltd. This cable runs through a 670-yard tunnel from Kemano power station to the terminal of the overhead line. Our illustration shows the insulator being lowered over an insulated cable end, in the outdoor switch yard. Because of the severe weather conditions a wooden shelter was built over this site while the work was in progress.

(To be concluded)



Lowering the insulator over the cable end at Kemano power station which is linked with the overhead line terminal by a Pirelli-General three-phase, 301kV oil-filled underground cable

F.B.I. Overseas Scholarships

TOWARDS the end of last week the Annual Reunion of Federation of British Industries Scholars took place. On the morning of Thursday, January 6th, the assembled scholars, together with guests and others interested in the scheme, assembled at F.B.I. headquarters to hear an address of welcome by Sir Norman Kipping, Director-General, and Sir Arthur Fleming, chairman of the Scholarships Committee. There followed an address on the origins, aims and progress of the scheme by Mr. W. P. N. Edwards ; and subsequently there was a general discussion. In the afternoon addresses were presented by Sir Arnold Plant, of the London School of Economics, on "Industry and Economics" ; and by Mr. J. L. Peterson, Warden, University House, East London, on "British Social Structure." In the evening a dinner was held at St. Ermin's Hotel, at which the scholars were seated at tables bearing national labels, from which an interested observer could see that they were drawn primarily from the Commonwealth and Latin America. The Minister of Supply, Mr. Selwyn Lloyd, was the chief guest. In the course of a speech Sir Norman Kipping remarked that there was more than a little truth in the idea that up to about 1920 the world was developed very largely by British engineers. In the course of developing the world we had also developed ideas about how engineers should be trained ; and to this day we retained a belief in practical as well as scientific training. The Federation was proud of its scheme and of its scholars, and it believed that as a result of experience here those scholars would be the better able to solve technical problems when they went back to their own countries. There were now about fifty scholars in Britain ; next year there might be 150. Within seven or eight years there should be some 1000 of them distributed over the world. Soon there would be some 350 scholars in this country simultaneously ; and more help was needed from industry to find the right places for them. On the following day the scholars visited the Royal Aircraft Establishment at Farnborough, and in the evening an address on "Training of Engineers in the United Kingdom" was presented by Dr. W. Abbott, Director of Studies, F.B.I., and discussed by representatives of the Institutions of Civil, Mechanical and Electrical Engineers.

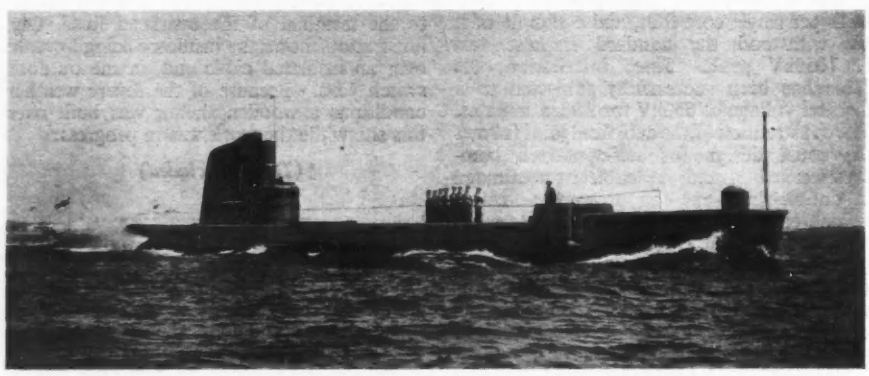
Naval Construction in 1954

RAYMOND V. B. BLACKMAN

No. II—(*Continued from page* 33, *January 7th*)

Submarine Conversions

A NUMBER of the twenty-three submarines of the " T " class built during the second world war have been reconstructed or rebuilt on similar lines to the American " Guppy " type. These boats originally had a displacement of 1090 tons standard, 1321 tons on the surface and 1571 tons submerged with a length of 265ft between perpendiculars and 273ft 6in overall with a beam of 26ft 6in and a draught of 12ft. They were armed with a 4in gun and eleven 21in torpedo tubes. Their propelling machinery comprised diesels of 2500 b.h.p., giving a surface speed of 15 knots, and electric motors of 1450 h.p., equal to a submerged speed of 9 knots. There is a considerable difference, however, between the " T " class conversions (e.g. " Turpin," " Taciturn," " Thermopylæ"), which are welded boats and have had an additional section of about 20ft built into them, and the " T " class " Streamlines," which are riveted boats and therefore cannot undergo the full conversion. The underwater speed of the " Tradewind," " Turpin " and " Taciturn," after reconstruction, streamlined hull, greater batteries, is reported to be increased by 6 knots. The reconstructed boats no longer mount guns. Several boats, including the " Totem," " Thermopylæ " and " Truncheon," have had their superstructure forward built up into a cruiser type bow.



Originally built in H.M. Dockyard, Devonport, during the second world war, having been laid down in October, 1942, launched in September, 1943, and completed in Januury, 1945, the " Totem " has been rebuilt. All the conning arrangements and antenna are now enclosed in one streamlined fin and the bows have been built up into a forecastle cutwater. She now has a submerged displacement of about 1700 tons with a length between perpendiculars of 235ft and an overall length of about 300ft. The speed is 15 knots, both on the surface and submerged

Australia

H.M.A.S. " Melbourne " (ex-H.M.S. " Majestic "), the second aircraft carrier intended for the Royal Australian Navy, was still under construction at the end of the year at the Barrow-in-Furness yard of Vickers-Armstrongs, Ltd. The light fleet aircraft carrier " Majestic " was laid down on April 15, 1943, and launched on February 28, 1945, but since she was transferred in an incomplete state to the ægis of the Australian Government she has sustained a series of constructional delays due to successive modifications in design. She was originally intended to be identical with Australia's first aircraft carrier, H.M.A.S. " Sydney " (ex-H.M.S. " Terrible") which has a displacement of 14,000 tons standard and 19,550 tons full load, but according to the revised figures recently issued officially she will have an increased overall length of 702ft and a reduced armament of twenty-five 40mm guns as compared with her sister ship. Four Admiralty three-drum type boilers and two sets of Parsons single reduction geared turbines, developing 42,000 s.h.p., will give her a designed speed of 24·5 knots. She will be equipped with an angled deck, an optical deck landing sight, and two steam catapults. Only three of the four " Daring " class destroyers originally projected are now to be completed, the " Waterhen " having been cancelled. These vessels, the largest of the destroyer type ever built in the Commonwealth, will be basically similar to the " Daring " class recently built in Great Britain for the Royal Navy, but the design has been modified to suit Australian conditions. They will have a full load displacement of 3700 tons and a sea speed of 30·5 knots. Only four of the six new fast anti-submarine frigates which it was announced in 1950 were to be built in Australian yards, three at Cockatoo Island and three at Williamstown, Melbourne, are now to be proceeded with. It was officially stated that although these ships were to be known as anti-submarine frigates, they would actually be more like destroyers in which the capacity for anti-submarine operations would be the principal factor in determining the provision of weapons and equipment. They are expected to be generally similar to the first rate anti-submarine frigates under construction in Great Britain Again, only four of the five fleet destroyers of the " Q " class permanently transferred from Great Britain which, it was announced in June, 1950, would all be fully converted to fast anti-submarine frigates, have in fact been reconstructed or are being rebuilt.

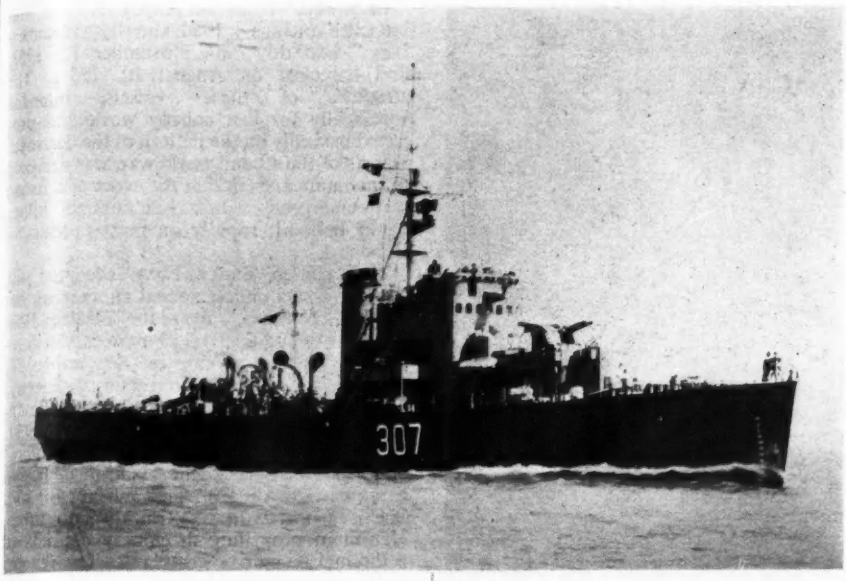
Canada

Work continued in 1954 on the light fleet aircraft carrier " Bonaventure " (ex-" Powerful "). This ship was laid down on November 27, 1943, and launched as the " Powerful " on February 27, 1945, at the Belfast yard of Harland and Wolff, Ltd., but her construction was stopped in May, 1946, and she was laid up for over six years in her unfinished condition. On July 25, 1952, however, it was announced that the long-suspended ship had been purchased by Canada for completion by her original builders, and she was renamed " Bonaventure." But before constructional work on the ship was resumed she was redesigned to handle jet aircraft, the modifications including the strengthening of the flight deck and elevators, improvements in deck arrester gear, and the installation of the new British steam catapults capable of shooting heavy aircraft into the air at a speed of 100 m.p.h. Plans were again revised subsequently to provide for a completely modern aircraft carrier embodying the angled deck arrangement. Recently the new mirror landing sight device was also included in her reconstruction and modernisation. She will turn out at over 14,000 tons standard displacement with a full load displacement of some 20,000 tons and a considerably increased length of about 700ft. Parsons single reduction geared turbines at which the steam pressure will be 350 lb per square inch will turn two shafts and develop 42,000 s.h.p., equal to a speed of 24·5 knots, being fed by four Admiralty three-drum type boilers. The ship is expected to be completed in 1956.

There was delay in the completion of the first of Canada's fourteen new construction anti-submarine escorts owing, it is officially stated, to the fact that the ships had been subjected to constant change because of international development in submarines and torpedoes. The total cost of these submarine chasers, on which design work started in 1949, is now estimated at 210,000,000 dollars or 15,000,000 dollars each, instead of the 8,000,000 dollars originally reckoned. Although first conceived in the anti-submarine frigate category, all were redesignated destroyer escorts with the symbol " DDE " instead of " DE " in 1954. With a displacement of 2000 tons standard and 2700 tons full load, all these vessels have a length of 366ft. The armament comprises four rapid-firing 3in, 50-calibre anti-aircraft guns of U.S. pattern in twin mountings, two single 40mm Bofors A.A. pieces and two ahead-projecting improved, triple-barrelled squid anti-submarine weapons. The main propelling machinery consists of a two-shaft arrangement of geared steam turbines designed for a speed of 27 knots. The main engines of the " St. Laurent " were supplied by Yarrow and Co., Ltd., Scotstoun, Glasgow, and installed by Canadian Vickers, Ltd., Montreal. The main turbines and condensers are of English Electric design. The remaining thirteen ships will have similar propelling machinery of British design, but manufactured in Canada. Six of these destroyer escorts have been launched, but there is still a lot of work to be done on each before it is completed, including the installation of electronic equipment and erection of the superstructure. The first vessel is expected to be completed late in 1955.

Of the twenty-four frigates of the Canadian " River " class, the " Antigonish," " Buckingham," " Lauzon," " New Glasgow," "New Waterford," "Penetang," "Prestonian" (illustrated), " Stettler " and " Toronto," were reconstructed and modernised, and all the remainder of these vessels are undergoing similar anti-submarine conversion except three.

The first of the new diesel twin-screw coastal minesweepers delivered to the Canadian Navy entered service early in 1954. The " Gaspe " (illustrated) and thirteen sister ships built by various Canadian yards are in



H.M.C.S. "Prestonian" was formerly a "River" class frigate. She has undergone anti-submarine conversion. In her original form the forecastle deck extended about two-thirds of her length, with low freeboard aft, but after reconstruction it has now been extended right aft. The extra space is very largely devoted to the equipment for detecting and fighting submarines, including some of the generating machinery which was changed from three steam and one diesel generators to two steam and two diesel, of greatly increased capacity. In the process of reconstruction her displacement has been increased from 1445 tons to approximately 2000 tons

design fundamentally similar to the new coastal minesweepers in the Royal Navy, but they have been developed by the Royal Canadian Navy to meet certain of its own requirements. The original programme of fourteen minesweepers of the "Gaspe" class was completed in 1954, but six of these vessels were transferred to France. Six replacements with the same names are being built for the Royal Canadian Navy. The construction of all the vessels of this type was shared between nine shipyards and all were built under cover.

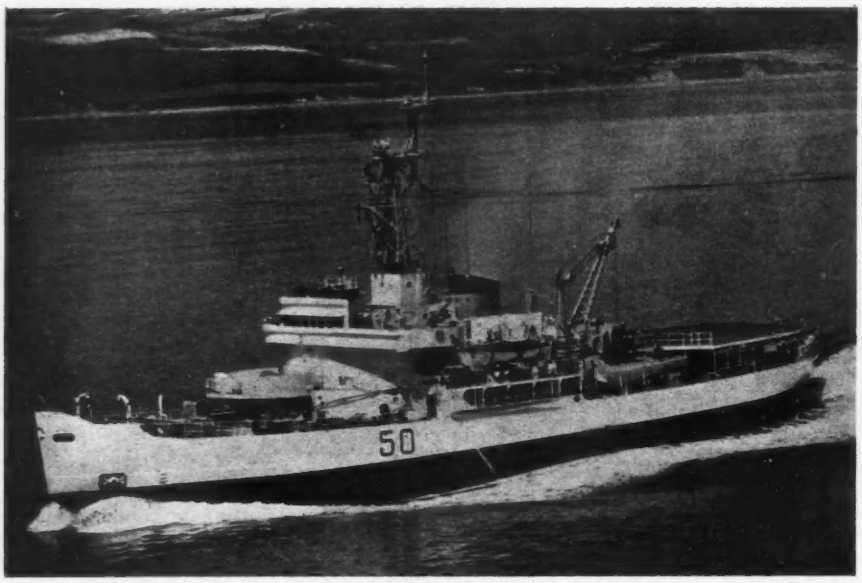
In the middle of July, at Halifax, the new naval icebreaking patrol vessel "Labrador" (illustrated) went through the final stages of equipping for her first and maiden voyage to Arctic waters.

United States

The world's largest aircraft carrier, the "Forrestal," took the water on December 11, 1954. Having been constructed in a graving dock, she was not launched in the accepted sense, but was floated out into the St. James River. Built by the Newport News Shipbuilding and Drydock Company, Newport News, Virginia, she was laid down on July 14, 1952, and is scheduled to be completed in June, 1955, which, if adhered to, will be a notable achievement for so large and complicated a ship. With a standard displacement of 59,650 tons and a full-load displacement of 75,900 tons, she will have an overall length of 1040ft (9ft longer than the liner "Queen Elizabeth," the largest mercantile vessel in the world), an extreme flight deck width of 252ft, a waterline beam of 129ft 6in, and a maximum draught of 37ft. Her main propelling machinery comprises four sets of geared turbines manufactured by the Westinghouse Electric Corporation, turning four shafts and developing an aggregate of 260,000 s.h.p., designed to give a maximum speed of 33 knots, the engines being fed by eight Babcock and Wilcox boilers. The ship was planned to carry and operate about 100 aircraft and to accommodate some 3500 officers and men. As originally projected, she was to have been flush decked with a retractable bridge, but as redesigned she is now to have the full-angled deck and the usual fixed island superstructure on the starboard side which the installation of the angled deck allows. But she will have hinged masts and stacks, which will be dropped when she has to go under Brooklyn Bridge, New York, to enter the naval shipyard there. She is the world's largest warship and the biggest aircraft carrier ever to have been built. Among the 16,000 workmen who have been engaged in her construction since the keel was laid only thirty months ago are a number of British-born men who served their apprenticeship in Clydeside, Belfast and North East Coast shipyards. More than 200,000 workers have contributed to the building of the ship and more than 1200 subcontractors have been involved. The design of this great floating and highly mobile bomber and fighter base called for a runway about 80ft longer than that provided by the flight deck of the largest existing carriers of the "Midway" class, to operate larger and heavier carrier based naval aircraft of the newest designs from her decks. As compared with the "Midway" class she will have greater catapult launching power, increased arresting capacity, larger elevators and higher hangar decks with a headroom of 25ft to accommodate the high tails of aircraft with supersonic speeds, and a television system to aid in landing on aircraft. There will also be additional armour and improved underwater protection. British ideas and inventions are incorporated in her construction, two of which may be mentioned particularly, namely, steam-operated catapults, and the angled (or "canted" in American parlance) deck, She has four British-designed catapults, from which thirty-two aircraft can be launched into flight in four minutes; four lifts; and three separate launching areas for aircraft. Contrary to former practice, her flight deck, constructed of steel, will by the reduction of openings in the hangar sides become a strength deck. As in British aircraft carriers, the bow will be enclosed up to the flight deck to make for seaworthiness in all kinds of weather. On the starboard side of her flight deck, which is 1036ft long, the "Forrestal" has a very large sponson jutting outboard over the sea from the control island superstructure for use as a parking area, while on the other side of the deck are outboard lifts, or deck-edge elevators, as they are known in the U.S. Navy, which bring aircraft from the hangar below up to the outside of the flight deck. The ship will carry atom bombers as well as jet fighters and reconnaissance aircraft. Her gun turrets will be automatically controlled, and operated from another part of the ship, and she has large rooms for decontaminating personnel in the event of atomic attack. Unusual features of her propulsion are the shipping of three rudders and two outboard five-bladed propellers operating with two four-bladed screws inboard. Her motive power is so designed and controlled that it will run automatically for hours should the engine-room staff be forced out of action by smoke or as the result of enemy operations. Three sister ships of the "Forrestal" are under construction or projected.

Two more destroyer leaders, the "Willis A. Lee" and "Wilkinson," were completed during the year. These ships were laid down as the largest destroyers ever designed in the United States, or in the world, but they were re-rated as destroyer leaders whilst under construction, and they constitute a category

H.M.C.S. "Gaspe" is a coastal minesweeper with a displacement of 390 tons, a length of 140ft between perpendiculars and 152ft overall, a beam of 28ft and a draught of 8ft 7in. She is armed with a 40mm gun, and carries a complement of three officers and thirty-five ratings. Her propelling machinery comprises two twelve-cylinder standard two-stroke G.M. engines each developing 1200 b.h.p. at 750 r.p.m. and driving the propellers through reduction gearing at 370 r.p.m. to give a speed of 16 knots



H.M.C.S "Labrador," a new Arctic patrol vessel was commissioned into the Royal Canadian Navy on July 8, 1954, and almost immediately won fame by completing the North-West Passage in twenty-seven days and being the first warship to do so. She has a displacement of 5400 tons with a length of 269ft and the wide beam of 63ft 6in. Her main propelling machinery comprises diesel-electric engines of 10,000 b.h.p., equal to a speed of 16 knots. She carries an armament of several short-range weapons, and has a complement of 173 officers and men

without parallel in other navies, being bigger than ships classed as light cruisers by some countries. Both ships were built by the Bethlehem Company, Quincy, the "Wilkinson" having been laid down on February 1, 1950, and launched on April 23, 1952, while the "Willis A. Lee," the last of the class of four to be completed, was begun on November 1, 1949, took the water on January 26, 1952, and broke her commissioning pennant at the Boston Naval Shipyard in the autumn. With a standard displacement of 3700 tons and a full-load displacement of 4730 tons, these vessels have a length of 450ft between perpendiculars, an overall length of 493ft, a beam of 49ft, and a draught of 20ft. Their armament consists of two 5in 50-calibre dual-purpose, fully automatic loading, rapid firing, radar controlled guns of a new pattern in single mountings, one forward and one aft; four 3in guns of the newer long-range 70-calibre pattern in twin mounts (to replace 3in 50-calibre); four fixed 21in torpedo tubes; and two Mark 108 anti-submarine warfare rocket launchers. They have two Westinghouse Electric Corporation geared turbines with De Laval double-reduction gears, turning two shafts and developing 80,000 s.h.p., equal to a designed speed of 35 knots, supplied with steam at a pressure of 1200 lb per square inch and a temperature of 965 deg. Fah. of superheat from four Foster-Wheeler boilers of the two-drum type. Their propulsion plant, although very light in weight, normally uses these high pressures and temperatures, and incorporates many advanced engineering features which have not been installed previously in fighting ships.

Three more orthodox destroyers are being built by Bethlehem Steel Corporation, the contract being awarded on February 2, 1954, and five more are projected. All these are of the same type as the "Barry," "Forrest Sherman" and "John Paul Jones" in an advanced stage of construction by the Bath Iron Works Corporation.

Bath Iron Works Corporation, Maine, who built the U.S.S. "Dealey" (illustrated), is also completing two sister ships, the "Cromwell," begun on August 3, 1953, and launched on June 4, 1954, and the "Hammerberg," laid down on November 12, 1953, and launched on August 20, 1954. The structure of these vessels, intended specifically for fast convoy work and projected basically on the pattern of the destroyer escorts of the second world war, was designed in such a manner that in the event of a future war emergency similar submarine killers could be built rapidly on mass production lines.

The first of a new type of ocean escorts, the U.S.S. "Dealey," somewhat larger than previous American destroyer escorts, was commissioned in the Boston Naval Shipyard on June 3, 1954. Laid down on October 15, 1952, and launched on November 8, 1953, she was built by Bath Iron Works Corporation, Maine. She is officially described as the prototype of a new class of modern anti-submarine vessels. With a displacement of 1450 tons standard and 1930 tons full load, she has a length of 314ft 6in, a beam of 36ft 9in and a draught of 18ft. Her propelling machinery comprises two boilers and a single-screw geared turbine of 20,000 s.h.p. designed for a speed of 25 knots. She has the latest anti-submarine weapons and anti-aircraft armament, including rapid-firing 3in guns in twin mountings fore and aft

The United States Navy accepted the world's first atomic-powered submarine, the U.S.S. "Nautilus," from the Electric Boat Division of the General Dynamics Corporation at Groton, Conn, on September 30, 1954. Engined by the Westinghouse Electric Corporation, she was laid down on June 14, 1952, and launched on January 21, 1954. With a displacement of 2500 tons standard and 3180 tons surface, the "Nautilus" has an overall length of 320ft and a beam of 30ft. She is armed with six 21in torpedo tubes. Her main propelling machinery consists of a thermal reactor power plant. The reactor compartment contains the nuclear reactor, steam generating equipment and the auxiliary systems. The engine-room contains the propulsion equipment, all steam-driven items, associated control panels and switchgear, as well as the main control point for the equipment in both compartments. The machinery is designed to be of sufficient power to give a speed of over 20 knots, with presumably an almost unlimited range. Reports give the output of each main engine as 1500 s.h.p. and the ultimate submerged speed as approaching 30 knots, but there is no official confirmation of these figures. The diving depth is given as 700ft. The complement is ninety-one officers and men. A sister ship to the "Nautilus," the "Sea Wolf," was begun on September 15, 1953, also by the Electric Boat Company, but she has engines of a different type manufactured by The General Electric Company. While the "Nautilus" has a thermal reactor and water coolant, the "Sea Wolf" is to have an intermediate reactor and a liquid metal coolant.

Other new kinds of submarines under construction include two new design high-speed attack submarines of the "Grayback" class with an overall length of 296ft, streamlined "guppy" snort equipment, and conventional propelling machinery of improved design, comprising a two-shaft arrangement of diesels built for "significantly high underwater speed."

Among the many other warships under construction in the United States during the year were seventy-six fleet minesweepers of the "Agile" class; thirty-four coastal minesweepers, displacing 335 tons, of wooden construction; a mine hunter of new design with a full load displacement of 358 tons, a length of 165ft and diesels turning two shafts; six steel-hulled, 180ft, diesel-driven escort patrol vessels of 800 tons displacement; nine 110ft diesel-driven patrol motor gunboats; an attack cargo ship of 17,988 tons full load; six dock landing ships of 11,270 tons full load; an inshore fire-support ship of 1500 tons light; twenty-six tank landing ships; forty utility landing craft; 1000 small landing craft; two ammunition ships of 17,400 tons full load; two store ships of 15,540 tons full load; four radar picket vessels converted from "Liberty" hulls; six fast fleet oilers with a displacement of 38,000 tons full load, and General Electric turbines of 28,000 s.h.p., equal to a speed of 20 knots; an icebreaker of 8775 tons; a minesweeper depot ship of 3100 tons, and five experimental minefield sweepers.

(To be concluded)

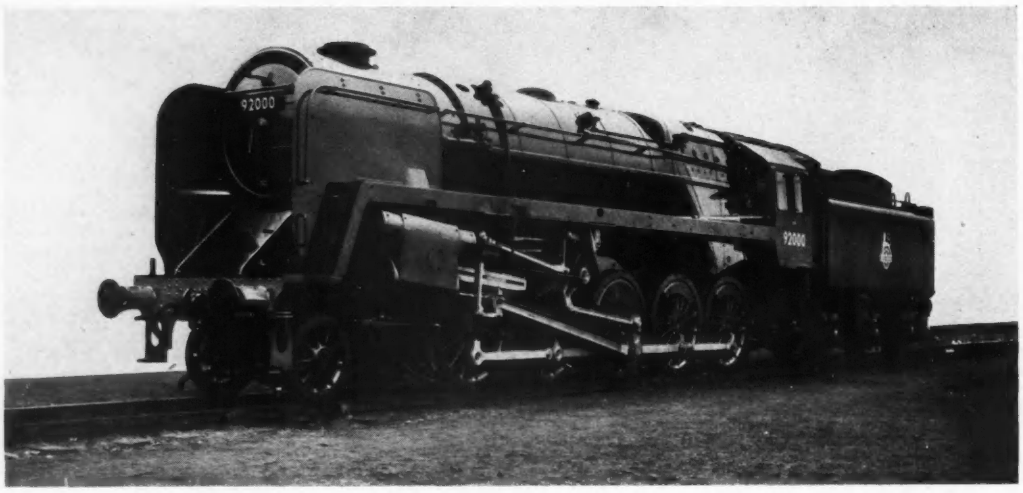
AERONAUTICAL ENGINES IN 1954

In the Napier "Nomad" engine now under flight development (top right), the cycle of a loop-scavenged two-stroke diesel engine is compounded with that of a gas turbine. An overall compression ratio of 31·5 : 1 and expansion ratio of 24 : 1 is achieved, leading to a fuel consumption in the order of 0·35 lb/s.h.p.-hour. Boost and fuel consumption can be maintained relatively constant over unusually great altitude changes, the former made possible by the use of an infinitely variable gear before the turbine. The gas turbine contributes substantially to the crankshaft output through gearing, apart from its principal task of charging the diesel engine. Total power (sea level take-off) developed in the gas turbine alone is 2250 h.p. and in the diesel engine alone 2660 h.p. The unit is rated at 3046 s.h.p.

The Rolls-Royce "Avon" axial-flow turbo-jet prototype was first rated at 6000 lb static thrust and weighed 2400 lb. The "Avon" "RA3" of 6500 lb had a civil version and weighed 2275 lb and the "RA7R" developed 9500 lb with reheat for a weight of 2470 lb. The "RA14," (bottom right), though not the latest mark, develops 9500 lb static thrust. The civil version in the "Comet" is rated at 9000 lb static thrust, and for a weight of 2860 lb has the lowest specific weight for an engine in its class. Fuel consumption is 0·84 lb/lb thrust/hr. Other marks of this engine reach to "RA28"

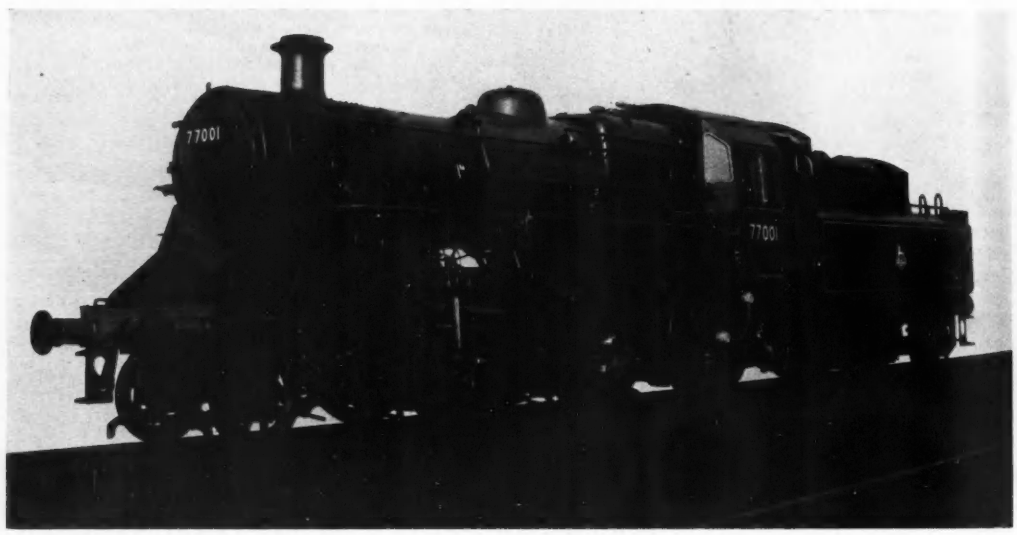
The Bristol "Proteus" turbo-propeller engine shown below is that fitted to the "Britannia" airliner. It develops 3780 e.s.h.p. at take-off and weighs without propeller 2810 lb. Normal fuel consumption is 0·48 lb/e.s.h.p./hr. The diameter is 39·5in. The "Proteus" "705" has twelve axial stages and a single-sided shrouded impeller. It incorporates a free power turbine of two stages. The mass flow is 42·5 lb, compression ratio 7·2 : 1, and maximum speed 12,000 r.p.m. The later "755" series will develop 4150 e.s.h.p. at take-off

BRITISH RAILWAYS' STEAM LOCOMOTIVES OF 1954



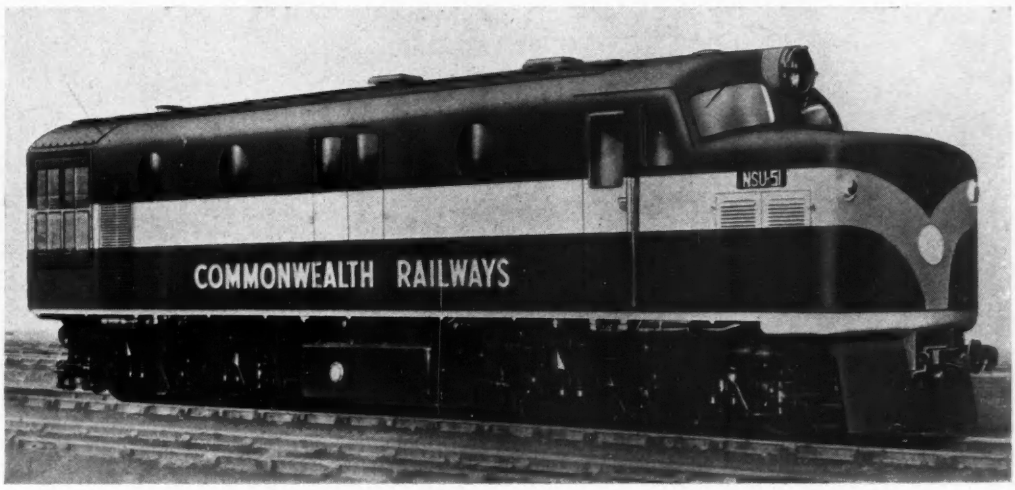
Class "9," 2-10-0 heavy-duty freight locomotive primarily intended for working mineral traffic. These locomotives, with a tractive effort of 39,667 lb, are the most powerful two-cylinder engines in service in this country. In full working order the engine weighs 86 tons 14 cwt. The boiler, with a working pressure of 250 lb per square inch, has a total evaporative heating surface of 2015 square feet, with a 535 square feet superheater. The total engine wheelbase is 30ft 2in, the coupled wheelbase of the 5ft diameter driving wheels being 21ft 8in

Class "3," 2-6-0 tender engine, designed for almost universal availability over main and secondary lines throughout the country. It weighs 57 tons 9 cwt in full working order, and has a tractive effort of 21,490 lb. Leading particulars: Two cylinders, 17½in by 26in; coupled wheel diameter, 5ft 3in; coupled wheelbase, 15ft 4in; total evaporative heating surface, 1051·3 square feet; superheater 190 square feet; grate area, 20·35 square feet; boiler pressure, 200 lb per square inch; adhesion factor, 5·08. The tender takes 6 tons of coal and 3500 gallons of water

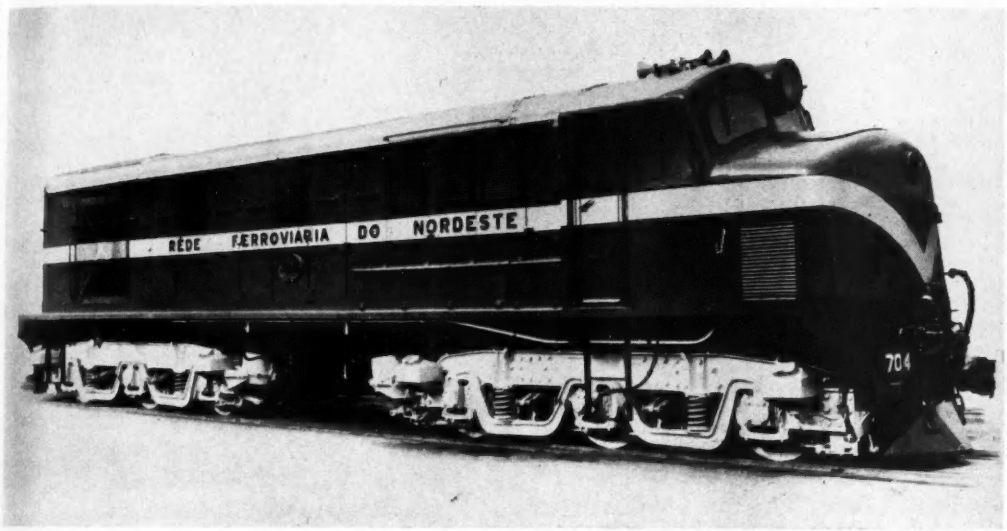


Class "8," 4-6-2 locomotive, with a tractive effort of 39,080 lb, and weighing 105 tons 5 cwt in full working order. Steam distribution to the three 18in by 28in cylinders is by Caprotti valve gear, and the boiler working pressure is 250 lb per square inch. The engine and tender are carried on roller bearing axleboxes throughout. Coupled wheels of 6ft 2in diameter have a wheelbase of 14ft, the total engine wheelbase being 36ft 9in. The tender, which has a water capacity of 4725 gallons and a coal capacity of 10 tons, is fitted with a steam-operated coal pusher

DIESEL-ELECTRIC LOCOMOTIVES OF 1954



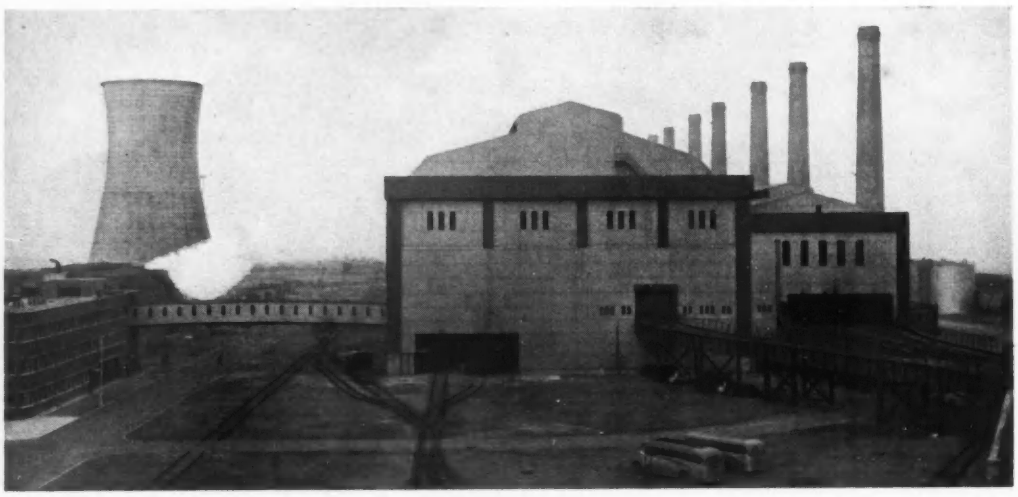
955 b.h.p. diesel-electric locomotive built for service on the Central Australia and Northern Australia lines of the Commonwealth Railways. Fourteen of these 3ft 6in gauge AIA-AIA locomotives are being supplied by the Birmingham Railway Carriage and Wagon Company, Ltd., as main contractors. In full working order a locomotive weighs 62½ tons, the adhesion weight being 41 tons. The continuous rating of the engine is 850 b.h.p. at 700 r.p.m., giving a generator rating of 535kW, 535V, 1000A. The tractive effort at one hour rating is 20,000 lb at 11 m.p.h., and at continuous rating 15,500 lb at 15 m.p.h.



1000 h.p. diesel-electric locomotive for passenger and freight service on the metre-gauge Rede Ferroviara do Nordeste in Brazil. The diesel-electric power equipment for the thirteen locomotives was supplied by the English Electric Company, Ltd., and the mechanical parts by the Vulcan Foundry, Ltd. They weigh 71 tons in working order and have a starting tractive effort (25 per cent adhesion) of 27,000 lb. The continuous tractive effort at 12 m.p.h. is 20,400 lb, and the locomotives are designed for a maximum speed of 60 m.p.h.

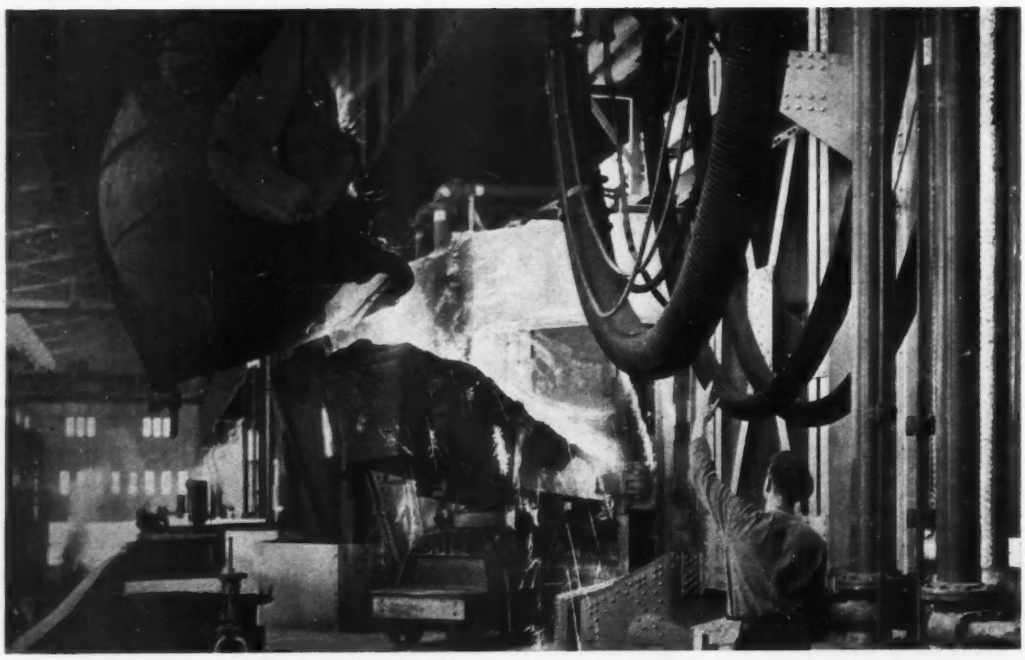
2000 h.p. diesel-electric locomotive for the Southern Region of British Railways. This $1C_0$-$C_0$1 locomotive weighs 132·8 tons and is designed for a maximum speed of 90 m.p.h. Its starting tractive effort is 50,000 lb and the continuous rating is 30,000 lb at 19·5 m.p.h. The six driving axles are each driven by a six-pole, nose-suspended motor through single reduction gearing, with a ratio of 19 : 61

LACKENBY OPEN-HEARTH STEEL PLANT



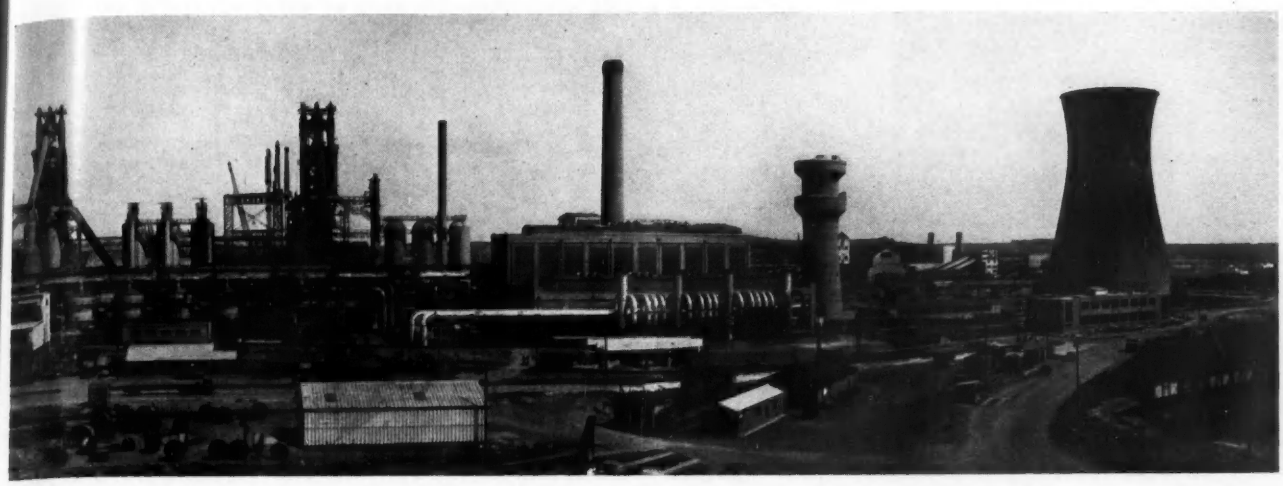
The Lackenby open-hearth steel plant of Dorman, Long and Co., Ltd., has been designed for an annual production of 625,000 tons of ingots. The site on which the plant has been erected is situated to the east of Middlesbrough, and extends over an area of about 600 acres. Work is now in hand preparatory to the installation of a universal beam and heavy section mill on the same site. The open hearth plant is the major part of the second stage of the company's post-war development programme. This view shows the melting shop building and the administrative block, with their connecting bridge. An important part of the Lackenby project was the installation of a railway system to link the site with the mineral lines of British Railways

The melting shop at Lackenby is 1083ft 4in long and contains three parallel crane bays for the casting cranes, charging machines and stock bay cranes. The first bay has a span of 75ft and the two latter spans of 65ft, the width of the building being 232ft. The charging bay is shown here. There are five tilting furnaces, each of 360 tons capacity, and two mixers each of which holds 600 tons. The furnace hearths are 50ft long and 18ft wide inside the lining at foreplate level, the furnace vessel being 62ft long over the chills and 31ft 6in over the buckstays. At present the furnaces are oil fired, but arrangements have been made to utilise a considerable proportion of coke-oven gas when the later stages of the development programme are completed

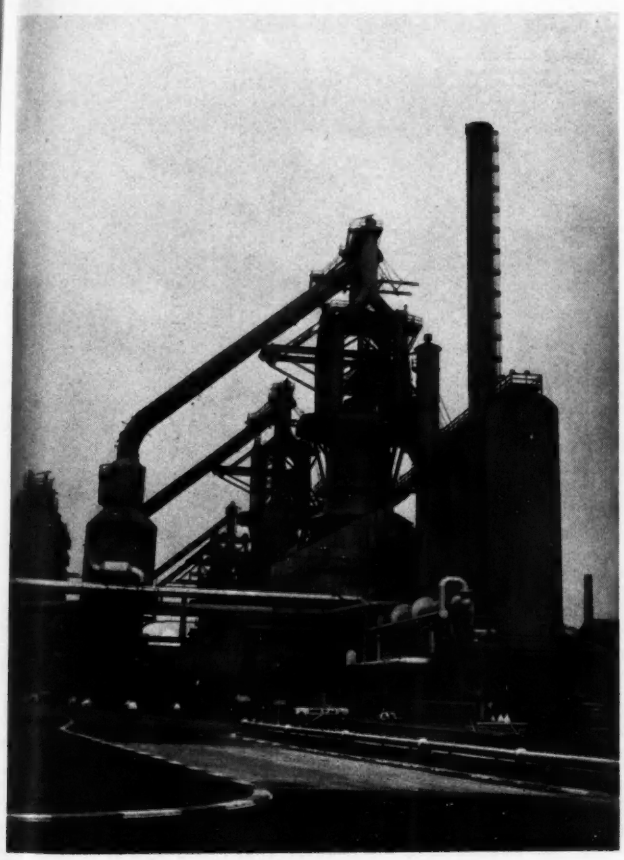


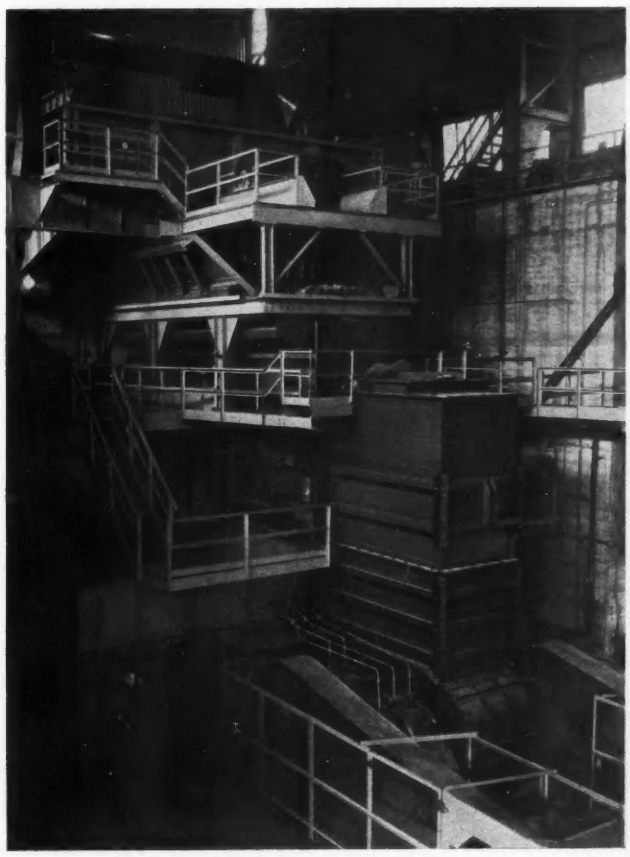
The two mixers installed in the melting shop have hearths 51ft long and 19ft 6in wide at foreplate level, giving a hearth area of 913 square feet and a depth at the centre of 7ft. The mixers have been designed for active working with a heat input of 570 therms an hour, and, when supplying the furnaces with about 6700 tons of metal a week can melt up to 1600 tons of scrap a week. On the charging stage side there are five doors, three on the front of the vessel and two in the tapered ends. Blast-furnace metal is charged through the two doors in the shoulders at the tapping side. The mixers, like the furnaces, are fitted with mixed fuel burners, enabling oil or coke-oven gas and oil together to be utilised

APPLEBY-FRODINGHAM IRONWORKS EXTENSIONS



The " Seraphim " plant of Appleby-Frodingham Steel Company is the post-war extension of the South Ironworks at Scunthorpe. Its completion means that the pig iron production of the works has been increased from 900,000 tons a year to 1,250,000 tons. The project has included the construction of two additional blast furnaces, named " Queen Anne " and " Queen Victoria," and their ancillary equipment ; a complete new ore preparation plant including primary, secondary and tertiary crushers and four sintering machines ; a conveyor system linking the new and existing ore preparation plants and the furnaces, and the installation of various subsidiary services. The upper view shows " Seraphim " from the west, the two blast furnaces, blower house and cooling tower being prominent. The sinter plant can be seen in the background of this picture. The left-hand lower view shows the " Queen Victoria " (No. 4) blast furnace, which has a hearth diameter of 28ft 6in, a bosh diameter of 31ft 9in, and an effective volume of 44,351 cubic feet. The " Queen Anne " (No. 3) furnace has a hearth diameter of 27ft, a bosh diameter of 30ft 3in, its effective volume being 42,372 cubic feet. The right-hand lower view is of the two-roll primary crusher, the rolls being 6ft diameter and 5ft wide, with minimum setting of 4½in ; there are also two 5½ft secondary crushers. The crushing plant deals with Frodingham ore, its normal rating being 700 tons an hour

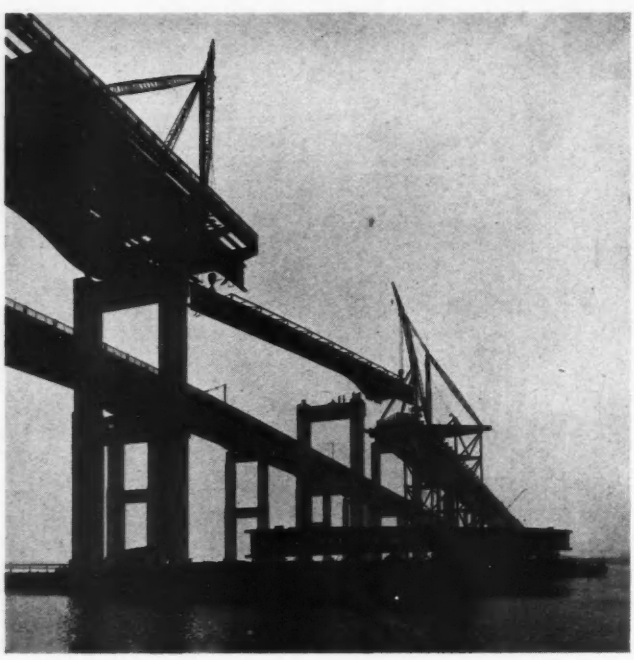




AMERICAN HIGHWAYS OF 1954

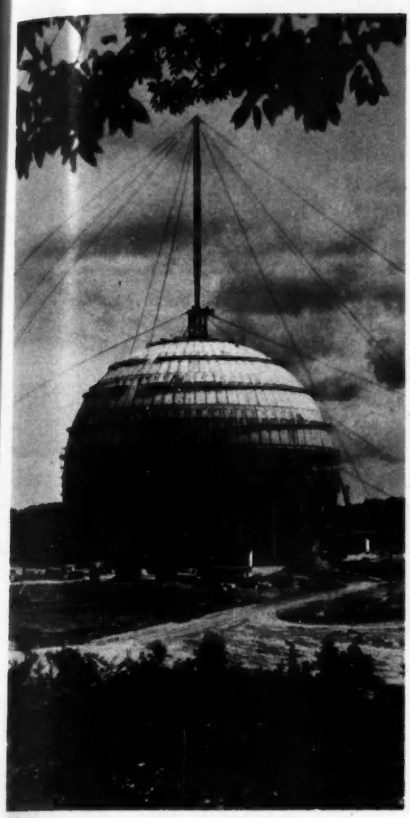
Section of the Garden State Parkway in Monmouth County, New Jersey. This important road constructed by the New Jersey Highway Authority is now open to travel for a distance of 143 miles between Irvington and the southern terminus at Cape May City. The remaining 22-mile portion to the northern terminus at Paramus is expected to be completed by the summer of 1955. The toll highway has two or three lanes each in the northbound and southbound roadways, which are separated by a centre island averaging 100ft in width. The road comprises a total of 282 overpasses, underpasses and bridges, including a 4400ft girder bridge over the Raritan River

The 4400ft long high-level bridge over the Raritan River (below) on the Garden State Parkway in New Jersey was opened to traffic in August, 1954. This illustration shows one of the four large haunch girders of the bridge being set in place, after having been floated to the construction site by barges. The largest bridge girders were 263ft long, 20ft deep and weighed 180 tons each. The highway bridge comprises two 30ft lanes of traffic separated by a 5ft centre "mall," and its foundations were designed to allow for a future widening to accommodate an additional 30ft lane

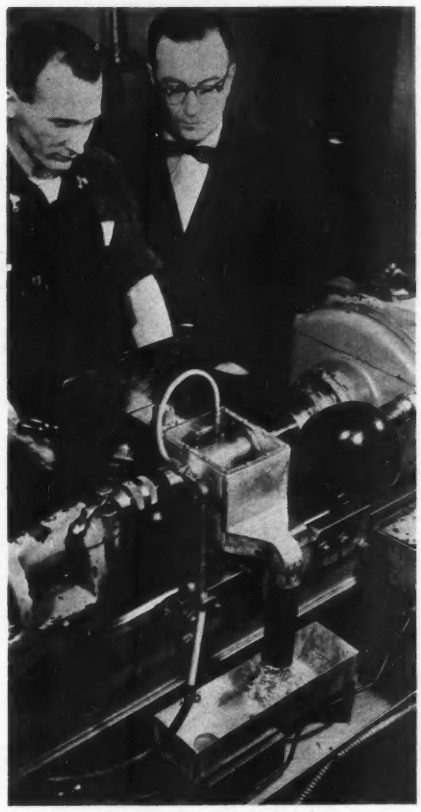


Construction (above) of the Manchester "interchange" on the New York State "Thruway" near Shortsville, New York. The major 400-mile portion of this toll road, from Buffalo to Suffern, New York, is now open to travel, and it is expected that the final section connecting with New York City will be completed by the summer of 1955. The entire highway will have no crossings "at grade" and no stop lights, and it has been designed for travel at 70 m.p.h. Maximum gradients have been limited to 3 per cent, and horizontal curves to 2 deg., with a minimum radius of 2800ft. The motorway provides two, and in some cases three, lanes in each direction

ATOMIC ENERGY IN AMERICA IN 1954

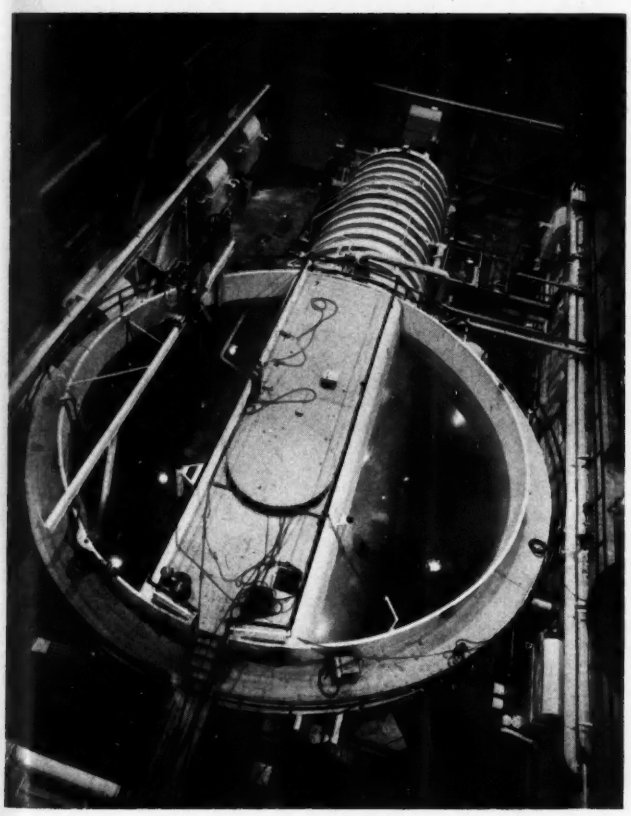


The 225ft diameter test sphere (left) at West Milton, New York, now houses a full-size hull section which contains the prototype atomic power plant of the submarine U.S.S. "Sea Wolf." After completion of the sphere, which was fabricated from 1in steel plates, the hull section was "launched" into the sphere through a temporary 30ft diameter hole. The test facility is operated for the U.S. Atomic Energy Commission by The General Electric Company

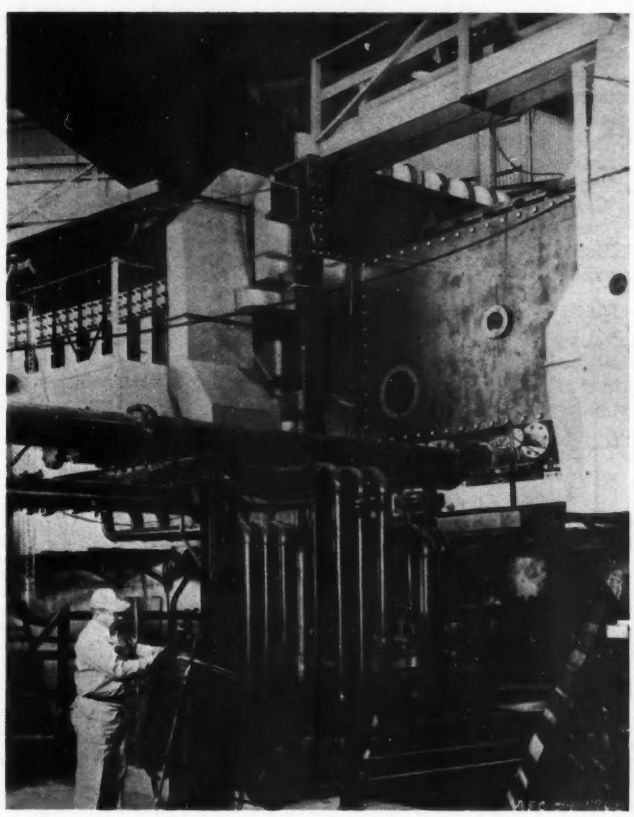


Machineability research with radioactive isotopes (right). The Aluminum Company of America is currently studying the machineability of various aluminium alloys, employing cutting tools which contain a percentage of radioactive tungsten. This "tracer" technique has been found to be so sensitive that the very slight wear of the tool in only two revolutions of the lathe can be detected by the amount of radioactive tungsten in the aluminium chips

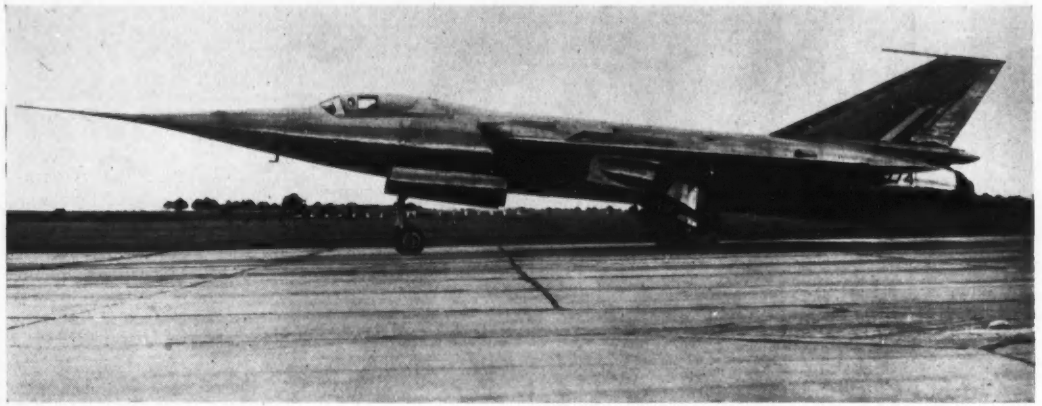
The Mark I prototype atomic power plant contained in a land-based submarine hull section at the National Reactor Testing Station of the U.S. Atomic Energy Commission in Idaho. The Mark II power plant, which is almost identical to the above unit, is now driving the submarine U.S.S. "Nautilus." The hull section shown passes through a water tank 50ft in diameter and 40ft high, so that the reactor compartment is completely submerged in water at all times.



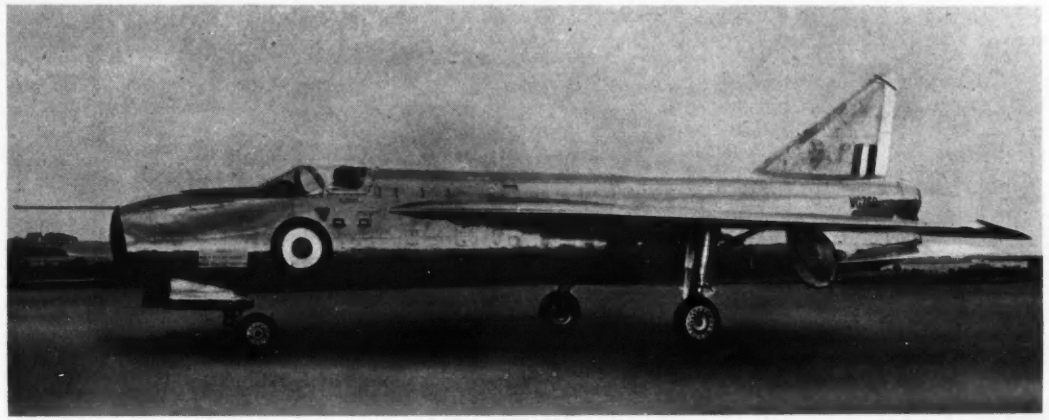
Magnet ring interior of the "Bevatron" particle accelerator at the University of California Radiation Laboratory in Berkeley. The magnet of the machine is 14ft high and has an outside diameter of 135ft. In addition to a proton beam, the accelerator generates a secondary beam of neutrons, which range in energy up to 6250MeV. At such energies, the particles emerging from the machine are equivalent to cosmic rays of medium energy



RESEARCH AND PROTOTYPE FIGHTER AIRCRAFT OF 1954



The latest British challenge in the realm of purely supersonic airframes is the Fairey "Delta II," shown above; several of the special requirements of supersonic aerodynamics can be noted. The fuselage has a low diameter/length ratio and a long, slender nose cone is adopted to reduce the wave drag which varies as the square of the cone angle. It is pointed to prevent the formation of a detached normal shock wave. Hence the wing root intakes for the engine, which is an unspecified mark of the Rolls-Royce "Avon". It's thrust with reheat is likely to be in the 15,000 lb category. Other significant details are the very small pilot canopy and a very thin wing of probably less than 4 per cent thickness chord ratio. It bears little resemblance to the company's first high-speed delta research aircraft. Aircraft in this category are stated to land at speeds well above 200 m.p.h. The first supersonic machine to fly in this country was the English Electric "P-1," shown below. It has a thin, sharply swept wing and an all-moving tailplane can be seen. Two Armstrong Siddeley "Sapphire" turbo-jet engines are mounted above each other in the fuselage and are served by a sharp-edged nose intake. Its maximum speed is thought to be less than Mach 1·5



Several aspects of the design, performance and construction of the Folland "Gnat" make it one of the world's most outstanding transonic aircraft. Its prototype, the "Midge" (above) was modified to take the only small engine available, until the Bristol "Orpheus" of about 4000 lb thrust is ready. The wing is made in one piece and does not house the guns, undercarriage or fuel, and it is stated that twenty-five "Gnats" could be built in the same number of airframe man-hours as five standard fighters and each at about one-third the cost. The weight of the "Midge" is only 4500 lb and the "Viper" engine thrust 1640lb. The machine has achieved supersonic speeds in dives

British Locomotives in 1954

ALTHOUGH this country is now probably approaching the last stage of the steam traction era, there is little evidence as yet of an appreciable decline in steam locomotive construction, either in the national works or those of many of the large private manufacturers, despite the growing interest at home and overseas in other forms of traction, particularly electric and diesel-electric locomotives. An indication of this fact is that the majority of the new locomotives built by British Railways during 1954 were of standard types, and by the introduction of two new standard designs, which brought the number of standard classes in service up to eleven of the originally proposed twelve. The new standard class "8" and "9" locomotives are illustrated on Plate 10, together with a new tender version of the class "3" which was put into service.

The three-cylinder 4-6-2 class "8" locomotive weighs some 105 tons 5 cwt in full working order and has a tractive effort of 39,800 lb. A point of particular interest in its design is that steam distribution is effected by Caprotti valve gear, in which separate inlet and exhaust poppet valves at each end of the cylinders are actuated by rotary cams. Drive for the cam boxes on the outside cylinders is taken from the intermediate coupled wheels by means of worm gearboxes. The drive from the gearboxes to the cam boxes is transmitted through tubular shafts. As the inside cam box is situated in an inaccessible position in front of the smokebox saddle its drive is taken from an extension of the left-hand cam box worm shaft through a bevel gearbox.

On this locomotive the big end cotter is locked on the inside connecting-rod in a way which is new to British Railways. It has a special serrated locking plate with serrations phased on both sides in such a way that four different positions of serrations relative to these formed on the back edge of the big end cotter can be obtained. By this locking arrangement an adjustment of $^{1}/_{32}$in is allowed in the cotter position and, as the taper on the cotter is 1 in 16, a final adjustment of about 0·02in is obtainable on the big end bearing.

The 2-10-0 class "9" heavy freight locomotives, of which twenty are to be built, are the most powerful two-cylinder engines in service in this country. They have 5ft diameter coupled wheels and weigh 86 tons 14 cwt in full working order. At 85 per cent boiler pressure the tractive effort is 39,667 lb. In these engines the balancing follows a principle not previously employed in this country, in which the rotating masses are fully balanced in the normal way, but the reciprocating masses are statically balanced to the equivalent of 40 per cent, by placing lead weights in the coupled wheels in the same phase on both sides of the engine. This leaves the fore-and-aft balance of the locomotive the same as if the normal procedure were followed, namely, of making the reciprocating mass balance coincide with the rotating mass balance; but there remains an unbalanced couple which, however, is no larger than that tolerated in three-cylinder locomotives without reciprocating balance. The new system has an advantage in that it reduces the "wheel" hammer blow (but not the "axle" hammer blow) and also saves approximately 2 cwt of balance weight. The weights themselves consist of plates clamped on each side of the coupled-wheel spokes to form pockets into which lead is inserted.

During the year the North British Locomotive Company, Ltd., delivered to the South African Railways eighty-nine 4-8-4 class "25" condensing engines with thirty condensing tenders, which completed the order placed in 1951 for ten "25 NC" non-condensing and ninety "25" condensing locomotives, and thirty condensing tenders. A detailed description of one of these 4-8-4 locomotives was given in our issue of February 19th last. These two-cylinder locomotives weigh some 121 tons in working order and at 75 per cent boiler pressure have a tractive effort of 45,360 lb. Other orders completed by this firm during the year included those for twenty-five 2-8-2 "Mikado" locomotives for the Spanish National Railways, and twelve 2-8-2 "River" class engines for the Nigerian Railway; a number of the forty-two 4-8-2 locomotives of a new type for the Sudan Government were also completed.

In addition to completing an order for thirty "WM" class engines for the Indian Railways, the Darlington works of Robert Stephenson and Hawthorns, Ltd., began construction of twenty-four class "WV" locomotives for the Western Australian Government Railways, which it is building in conjunction with Beyer, Peacock and Co., Ltd.

Amongst the Beyer-Garratt locomotives built during the year by Beyer, Peacock and Co., Ltd., were the first of fifteen new class "20" locomotives for the 3ft 6in gauge Rhodesia Railways. These locomotives have a 4-8-2+2-8-4 wheel arrangement and weigh 225 tons in working order, the designed axle load being 17 tons. At 85 per cent boiler pressure they have a tractive effort of 69,330 lb.

Of the eighty-seven steam locomotives completed by the Vulcan Foundry, Ltd., fifty-six were 2-8-0 "J" class engines for the Victorian Railways; sixteen were metre-gauge 4-8-2 engines for the Antofagasta and Bolivia Railways; and fifteen 2-8-2 "River" class engines for the Nigerian Railways 3ft 6in gauge lines.

Diesel-Electric Locomotives

In addition to the large number of steam locomotives built in this country in the works of private manufacturers, diesel and diesel-electric locomotives are being made in increasing numbers for overseas railways. Two of these diesel-electric locomotives, together with the latest 2000 h.p. locomotive placed in service by British Railways, are illustrated on Plate 11. Another plate (Plate 7) shows some electric locomotives which are dealt with elsewhere in our review of the electrical industry during 1954.

One of fourteen AIA-AIA diesel-electric locomotives ordered by the Commonwealth Railways of Australia from the Birmingham Railway Carriage and Wagon Company, Ltd., is illustrated on Plate 11. These locomotives have 955 b.h.p. Sulzer engines and their electrical equipment is supplied by Crompton Parkinson, Ltd. They have a maximum starting effort of 26,800 lb and when they were ordered it was specified that the locomotives should be capable of hauling 202-ton trains up a 1 in 60 uncompensated gradient, but as constructed they are actually capable of hauling 270 tons up this gradient. The light rails on the 3ft 6in gauge track made it necessary to restrict axle loading to 10·3 tons and this figure has been attained without the use of any light alloys in the structural members.

As part of the contract four spare 4ft 8½in bogies are being provided so that it will be possible to use two of the new locomotives on standard gauge sections of the Commonwealth Railways. When the new 4ft 8½in line from Stirling to Leigh Creek has been built and the line on from Stirling to Marree converted all the lines of the southern section of the system will be standard gauge. As these lines will be able to take 12-ton axle loads all the electrical equipment of the present locomotives is designed to take full advantage of this increased loading at starting. Full constructional details of these locomotives were given in our issue for March 5, 1954.

The diesel-electric locomotive for Brazil which is illustrated is one of thirteen built by the English Electric Company, Ltd., with the mechanical parts supplied by Vulcan Foundry, Ltd. These AIA-AIA locomotives have a diesel engine rated continuously at 1000 b.h.p. at 850 r.p.m. and driving a six-pole d.c. main generator supplying the four traction motors. The locomotives weigh 71 tons and are designed for a maximum speed of 60 m.p.h., the continuous tractive effort at 12 m.p.h. being 20,400 lb.

Early in the year delivery began of the forty-eight class "X" diesel-electric locomotives ordered by the Western Australian Government Railways. The Metropolitan-Vickers Electrical Company, Ltd., which is making the electrical equipment, states that eighteen have been dispatched up to date. The mechanical parts are being made and the locomotives erected by Metropolitan-Vickers-Beyer Peacock, Ltd., at Stockton-on-Tees. These locomotives were stated to form the largest diesel-electric traction order ever placed with a British firm, the order being valued at £2,250,000 sterling. Each locomotive has a two stroke Crossley diesel engine, which, under the operating climatic conditions and the specified requirements, delivers 1105 h.p. and gives a maximum service speed of 55 m.p.h. With a designed axle load of 10 tons, the locomotives weigh 77½ tons in full working order.

It is of interest to note that in November last the 2000 h.p. "Fell" main line diesel-mechanical locomotive was again placed in service by British Railways This locomotive was withdrawn from service shortly after its introduction in January, 1952, for modification and general trials.

A programme involving an expenditure of more than £2,000,000 for the introduction of lightweight multiple-unit diesel railcars was announced early in 1954 by British Railways, and one of the new cars was described in our issue of May 7th. These cars will partly supplement and partly replace existing steam services in many parts of the country; it is expected that their greater flexibility and economy will provide better facilities and create new business. The basis of these new trains, a number of which are already in service, is a two-car set. One vehicle is powered by two horizontal engines of 125 h.p. under the floor, and the other is a trailer or a motor-coach as required. Each two-car set can be driven from either end, and can be operated as a self-contained unit seating about 130 passengers. Alternatively, the cars can be assembled into multi-unit trains of four, six or eight vehicles to suit traffic requirements.

Development of the Lost-Wax Process of Precision Casting, 1949–53*

No. II—(*Concluded from page 28, January 7th*)

By J. S. TURNBULL†

The author discusses the limitations of the original lost-wax process (1945–49) *and describes improved methods developed in the precision casting shop of the Metropolitan-Vickers Electrical Company, Ltd., by which the process has extended its application in industry. In the technique of wax injection, methods are described for eliminating "draw" in wax patterns and for making accurate patterns considerably larger in size. Wax injection machines are also described. In the manufacture of moulds the new Investment X technique of shell moulding is described.*

Vacuum Casting

Vacuum casting is often intended to refer to the melting and casting of metal in vacuum. In this context, however, it is limited to the exclusion of gas from the mould cavities at the moment of pouring.

It has already been stated that a main advantage of the Investment X shell mould over the solid mould is the higher definition obtainable owing to the total exclusion of the gas in the mould cavities by the incoming metal. There are, however, instances where this advantage is precluded owing to thinness of casting section, length, &c. Furthermore, the shape may not lend itself to centrifugal casting.

In such instances the reduction of atmospheric pressure outside the walls of the Investment X shell mould can be of great assistance in filling the mould with molten metal.

A second method of casting is designed to remove a high percentage of air and gas from the mould cavities before pouring the metal. In this instance the mould (at 1000 deg. Cent. or at any other desired temperature) is placed in a metal canister so arranged that it has a ceramic pouring funnel sealed into the lid. The pouring funnel is blanked off by a metal diaphragm located at its smallest diameter. The canister is then evacuated to any desired pressure giving a "rough" vacuum. Molten metal is poured quickly into the funnel which will fill to the top before the diaphragm burns through. The metal then pours into the mould and the casting is made.

Perhaps the point of greatest interest in this method of casting is the fact that a "cold" mould at 25 deg. Cent. can be filled with as good definition as a "hot" mould at 1000 deg. Cent., thereby giving a smaller grain. Austenitic stainless steel castings made for comparison differed in grain size by a factor of 20.

When casting some steels difficulty was experienced with gases evolved from the molten metal owing to the sudden reduction in pressure. It became necessary to increase the pressure in the canister to 26in of mercury.

The optimum results should be obtained in instances where the gases have been removed from the molten metal before casting.

Designing the Mould for Progressive Solidification

When the shape and sectional differences of a casting make it difficult to obtain a sound casting free from shrinkage defects it is possible to promote thermal gradients in the mould as an effective remedy. The methods used are as under :—

(1) Use of cooling slots in a solid mould at 1000 deg. Cent., through which slots cold air is blown for a specified time.

(2) Use of a combination of heating and cooling slots in a mould at 1000 deg. Cent., whereby a much higher gradient is attained. A suitable mixture of aluminium and iron oxide is burnt in the heating slot to elevate the mould temperature to 1200 deg. Cent. and the cooling slots reduce the mould temperature to 600 deg. Cent.

(3) Use of a heat-resistant metal tube which is coiled around an Investment X shell mould adjacent to the heavy section of the casting. Its employment would have promoted shrinkage porosity in a casting made by normal technique. Cold air is blown through the tube for a specified time to reduce the mould temperature locally before the metal is poured.

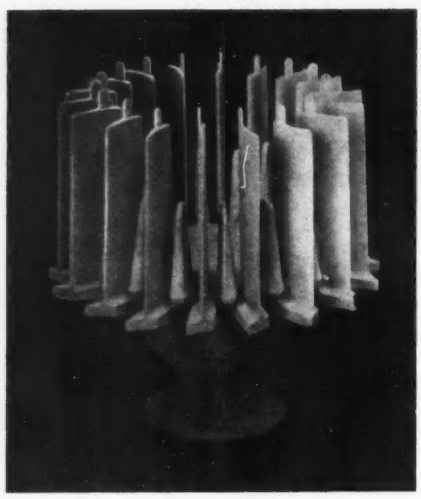
(4) Use of heaters which are cast simultaneously with the required components. Fig. 7 shows this applied to the Investment X shell-mould technique when casting compressor blades of constant sectional area. The presence of the heater slows down the rate of solidification of the blade at its root section and promotes soundness.

(5) Use of metal chills which are affixed to the wax patterns at those sections where quick freezing is required to promote soundness.

The five instances quoted above are not methods which should be used liberally. Wherever it is possible for the casting design to be modified to a shape better suited to progressive solidification this course should be taken.

Mechanical Properties of Precision Cast S.80

The mechanical properties of several hundred fully heat-treated S.80 castings have been determined over a number of years. In general the properties are : ultimate tensile strength, 40–50 tons per square inch ; yield, 35–45 tons per square inch ; elongation, 5–10 per cent.



One of the mould cavities is shown sectioned. These heaters are cast simultaneously with the blades and enable progressive solidification to give sound castings free from shrinkage defects.

Fig. 7—Centrifugal assembly of sprayed wax patterns showing tapered heaters interposed between blades

Tensile strengths of up to 65 tons per square inch have been obtained, but these are exceptional. The hardness value of heat-treated castings are in general 240–300 Vickers diamond pyramid number, the equivalent tonnage of which would be 50–60 tons per square inch. That the actual strength approaches so closely to the intrinsic strength is indicative of the soundness of the S.80 castings. The reduction in ultimate tensile strength is probably due to a combination of small non-metallic inclusions, together with the anisotropy resulting from very large grain size. The grain size of S.80 castings when made in moulds at 1000 deg. Cent. is often $\frac{1}{16}$in to $\frac{1}{8}$in, as compared with $^1/_{1000}$in for forged material.

The fatigue strength of fully heat-treated S.80 is ± 30 tons per square inch as determined by reverse bending tests on cast gas turbine compressor blades. This represents a very high ratio of fatigue strength to ultimate tensile strength.

In considering the effect of new developments it is not true to say that they have increased the mechanical properties of a sound casting. The defect most deleterious to mechanical properties is unsoundness resulting from interdendritic shrinkage. The new developments described in this paper combine to reduce this defect by means of (1) centrifugal casting, (2) Investment X mould, and (3) promotion of progressive solidification.

Centrifugal casting (1) has advantages in that the higher flow of molten metal, together with the compacting of the metal in the mould cavities, allows the pouring temperature to be far lower than is possible in the process described in my former paper[1].

The Investment X mould (2) with its low thermal capacity and high permeability allows the molten metal to run farther and the trapped air to escape faster.

Where methods (1) and (2) do not enable sound castings to be made, progressive solidification (3) can be achieved by modifying the solidification rates of the casting. Fig. 7 shows taper heaters adjunct to compressor blades.

Economics of Lost-Wax Casting

The overall advantages of Investment X shell moulds combined with centrifugal casting has cut the cost of castings by approximately 40 per cent. This has been effected by :—

(1) Decreased cost of moulds, the loose packing material being used over and over again.

(2) Operations of shell manufacture ; dewaxing, investment and pouring are simpler than corresponding operations in solid-mould technique.

(3) Owing to the removal of the wax in the trichlorethylene plant the mould need only be heated up until its temperature throughout is stabilised at 1000 deg. Cent. No "baking" is required, fuel being thereby saved proportionately.

(4) The mould boxes have longer life with a reduction in replacement charges.

(5) Centrifugal pressure casting gives a greater consistency in the castings.

(6) The greatest saving is to be found in the reduced scrap percentage. For example, the scrap percentage on production of compressor blades has fallen from 35 to 15 per cent. This includes 7 per cent casting scrap and 8 per cent X-ray scrap.

Conclusion

If the broadest view possible is taken of the lost-wax process and its potentialities, it is now clear that process simplification has been completed to a stage where further economies are unlikely to be achieved.

Wax is the cheapest pattern material permitting the lowest die cost. An integral ceramic shell mould of controlled thickness is the only receptacle for molten metal which can claim effective mechanical design for economy. Pressure casting by gravity is the cheapest method of filling a mould, followed by centrifugal and vacuum techniques which are slightly greater in expense and complications.

Furthermore, process simplification is a very necessary prelude to mechanisation, which will be an essential step in the manufacture of cheaper and larger castings.

It is not unreasonable to anticipate that the lost-wax foundry of the future will have wax patterns made on fully automatic or semi-automatic machines, moulds of 50–100 lb capacity manufactured on mechanised investing machines, and castings poured by 2-cwt induction furnaces re-melting small steel ingots.

Reference

[1] Turnbull, J. S.: 1950 *Proc. I.Mech.E.*, Vol. 162, page 66, "'Lost Wax' Process of Precision Casting."

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* Paper presented to the Institution of Mechanical Engineers, December 31, 1954. Abridged.

† Works Development Engineer, Metropolitan-Vickers Electrical Company, Ltd., Manchester.

Underwater Survey.—We are informed that an underwater seismic survey has begun in the waters off the Persian Gulf territory of Abu Dhabi, from the vessel "Sonic," to explore the possibilities of oil-bearing formations beneath the sea bed.

Industrial Research.—In an article which he has contributed to the *Board of Trade Journal*, Sir Harry Pilkington, president of the Federation of British Industries, has emphasised the importance of investment in research. More effort, certainly, is needed, Sir Harry says, not so much in fundamental research as in the application of scientific discoveries to products and manufacturing processes. In this, Sir Harry continues, the work of the industrial research associations is invaluable and is worthy of still stronger support. To-day the development of any invention is likely to be enormously costly and can only be achieved by team work not only within firms but within industries as a whole. Sir Harry stresses that "we simply cannot afford a dog-in-the-manger attitude," and calls for a greater realisation of the fact that the advantages to an industry and to the country of pooling knowledge far outweigh the risk to the individual firm of losing a temporary lead which it may not be able to exploit fully.

American Water Power Schemes in 1954

BY OUR AMERICAN EDITOR

PROGRESS of civil engineering construction during the past year was influenced much by political developments and is likely to be subject to renewed change early in the New Year on account of the Congress of the United States now being under Democratic control. Since the beginning of the Eisenhower administration there has been a noticeable trend away from entirely Federal control of major public works, such as reclamation, flood control, irrigation and hydro-electric power generation. In the course of 1954 this Republican policy had led to such a curtailment of new development and design in the U.S. Bureau of Reclamation that some hundred engineers were discharged from the staff of the engineering department.

Several important reports dealing with long-range planning of Federal construction policies were being compiled during the past year and will be in the hands of President Eisenhower early in 1955. It is believed that these reports will form a basis for the legislative recommendations which will be made to the Congress by the Administration. Among the more important of these reports is the Clay committee's report on how to implement the President's proposal for a highway building programme which will involve the expenditure of 100 million dollars during the next ten years. Another report by the Hoover commission deals with the development of the power resources of the United States. And, finally, the Committee of the American Cabinet, under the leadership of the Secretary of the Interior, has prepared a report on the proposed development of American water resources. Perhaps the most important of these reports, from a construction point of view, is that prepared by the Hoover commission. Under its terms of reference the commission was required to seek ways and means of reducing Federal activity in the development of both single-purpose hydro-electric power schemes and entire multiple-purpose river control schemes. It is believed that, when published, the report will strongly recommend the Federal Government to adopt President Eisenhower's so-called "partnership policy" of allowing local interests to develop hydro-electric power on the streams of the United States. It is expected to go even further, by suggesting that Federal policy concerning flood control and navigation improvements be changed so as to obtain payments for all benefits derived from such works by the local beneficiaries. Finally, the Hoover commission is expected to recommend a merger or consolidation of the now separate functions of the Bureau of Reclamation, on the one hand, and the U.S. Army Corps of Engineers, on the other hand. Many civil engineers in America to-day feel that the lack of co-operation and the frequent feuds between these two separate bodies engaged in reclamation work has gone on too long and there is now hope of an amicable union being established.

Palisades Dam

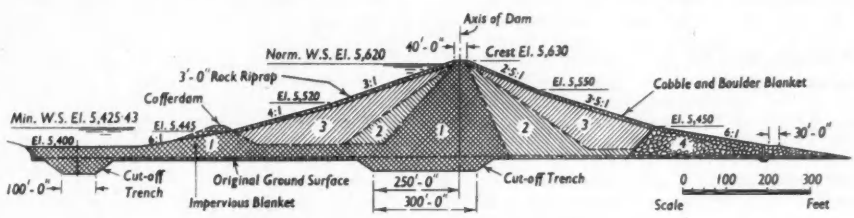
The construction work proceeding at the Palisades dam in Idaho during the past year was representative of the current efforts of the U.S. Bureau of Reclamation to provide improved irrigation storage in the Upper Snake River valley. It is hoped that the costly losses in crop production due to drought which periodically have plagued the farmers in this extremely fertile valley will come to an end with the construction of the Palisades project. These recurring losses, which in some years have run as high as 7,000,000 dollars, will be eliminated by providing a dependable supplemental supply of water from the new storage reservoir. Palisades dam also will aid in the expansion of irrigation in Southern Idaho by helping to make available a full supply of water to two blocks of sagebrush-covered lands. As a multiple purpose feature of the development, 114MW of installed hydro-electric generating capacity will be provided to meet the growing power needs of the region.

The Palisades dam scheme embraces the largest earth-fill dam ever constructed by the Bureau of Reclamation and a 1,400,000 acre-foot reservoir. The dam is situated in Eastern Idaho, 8 miles west of the Wyoming border and approximately 44 miles east of the city of Idaho Falls. The Palisades power station will consist of four generators, each rated at 28·5MW. The estimated annual output will be 134 million kWh of primary hydro-electric energy and 385 million kWh of secondary energy. Initial power is scheduled to be generated in 1956. The estimated cost of the Palisades scheme is 76,601,000 dollars, of which 53,355,000 dollars will be repaid to the Federal Treasury by the water users and through the sale of power.

The dam will be a rock-faced, earth-fill structure, having a total volume of approximately 13,800,000 cubic yards. The structure will be 258ft high, 2200ft long at the crest, 2250ft wide at the base, and 40ft wide at the crest. The elevation of the crest will be 5630ft above sea level. The dam will be situated on the Snake River, which is second in flow only to the Columbia in the Pacific Northwest of the United States. The origin of the Snake is in the southern part of the Yellowstone National Park, on the west side of the Continental Divide in Wyoming. The left abutment of the dam consists of rock of igneous origin—andesite—which is very hard and stable. The foundation and the right abutment of the dam consist of tilted sedimentary beds, mainly comprising highly compacted clayey silt stones, which will be adequate to support the weight of the dam.

A controlled discharge spillway, consisting of one 28ft inside diameter tunnel, 1850ft long, will carry surplus flows of the Snake River past the dam. It will extend from the surface of the reservoir through the left abutment to the river below and will have a maximum capacity of 48,000 cusecs. Two concrete tunnels, which are lined with steel from the dam axis to the outlet end, constitute the outlet works. They have a capacity of 30,000 cusecs at a reservoir elevation of 5497ft and each has an inside diameter of 26ft. One of these tunnels carries water to the penstocks and both served as diversion tunnels during construction. The power station is being constructed at the downstream toe of the dam at the left abutment. It will be approximately 100ft by 246ft wide and will be the first brick power station constructed by the Bureau of Reclamation. The dam is creating a reservoir approximately 20 miles long and 3 miles across at the widest point. It will extend about 5 miles across the Idaho-Wyoming border, have a surface area of 16,100 acres, and a capacity of 1,400,000 acre-feet. The operation of the Palisades reservoir will be co-ordinated with that of the existing American Falls and Jackson Lake reservoirs to ensure that a maximum volume of storage water can be carried over in all three reservoirs from wet cycles to dry cycles.

When construction of the dam began in the summer of 1952, the Snake River was diverted around the work area through a 1450ft long diversion channel cut across the natural bend of the stream. In 1953 it was further diverted through the concrete-lined power and outlet tunnels in the left abutment of the dam. The body of the earth-fill dam will be a rolled embankment. The centre and most of the base will be an impervious core, blanketed by zones of stable, free-draining materials. A layer of rock will be placed on the upstream and downstream faces of the dam to prevent erosion. Two concrete cut-off walls will extend along the left abutment and two cut-off trenches will underlie the dam. As shown in the accompanying drawing (Fig. 1), the impervious section of the dam will consist of deposits of clay, silt and sand, and a surrounding zone of the same material mixed with some gravel, cobbles and small rock fragments. The material placed in these impervious zones was compacted into successive layers, 6in deep, by 20-ton sheepsfoot rollers, each 5ft in diameter, which made an average of twelve passes over it. The outer slopes and crest of the earth-fill embankment will be of free-draining sand, gravel and cobbles compacted into successive layers of 12in depth by crawler tractors. The upstream face of the dam will be a blanket of rock riprap and the downstream face a layer of rock cobbles. The materials for the earth embankment and the aggregate for concrete were found to be available in a number of borrow areas near the dam site.



	Quantity (cu. yd.)	Material
Zone 1	5,000,000	Selected clay, silt and sand compacted by tamping rollers to 6in layers
Zone 2	3,770,000	Same as zone 1 plus gravel, cobbles and rock fragments to 5in maximum
Zone 3	3,570,000	Sand, gravel and cobbles compacted by crawler tractor to 12in layers
Zone 4	880,000	Rockfill dumped in 3ft layers
Rock blanket	310,000	Minimum size 5in
Riprap	270,000	From ¼ cubic feet to 1 cubic yard
Total	13,800,000 cubic yards	

Fig. 1—Cross-section of Palisades dam in Idaho

Folsom Dam

By the end of 1954, almost all of the Folsom dam structure on the American River near Sacramento, California, had been completed. While this structure is of considerable importance from the point of view of local flood control, irrigation and power generation, it is of even greater interest to American civil engineers as the first major case of co-operation between the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation. In this particular case, the dam is being constructed by the former and the power station by the latter body. The Folsom dam is creating a reservoir with a gross capacity of 1,000,000 acre-feet. Of this, about 88,000 acre-feet will be utilised to maintain a minimum power pool while the remaining 912,000 acre-feet will be operated in the joint interest of flood control, municipal and industrial water supply, irrigation, power and incidental recreation use. The maximum flood control reservation, which will vary seasonally with the flood hazard, will be 400,000 acre-feet. The Folsom power turbines will have a gross head ranging from 196ft to 336ft, and an installed capacity of 162MW. The concrete river section of the dam is founded on fresh granite rock. The earth wing dams and eight of the saddle dikes are, in general, founded on decomposed granitic soils, their cut-off trenches being taken down through surface soils of relatively light density to weathered but firm granite.

The maximum height of the concrete river section of the dam, from foundation to roadway,

is 340ft, and the combined length of the concrete overflow and non-overflow sections is 1400ft. About 960,000 cubic yards of excavation and 1,170,000 cubic yards of concrete will be required for the concrete dam and its stilling basin. All sections of the dam were designed as vertical gravity sections 1ft wide, under various assumptions as to pool and tailwater elevations, uplift and earthquake loading. Each of the eight Tainter gates on the spillway crest is operated by its own individual motor-driven hoist. The five-bay river spillway section has four 5ft by 9ft combination flood control-irrigation sluice outlets in each of two tiers. Each sluice is controlled by two 5ft by 9ft hydraulically operated slide gates in tandem, one acting as the service gate and the other as an emergency gate. An 8ft by 15ft fixed-wheel face gate is also provided to give access to the sluices for maintenance. An operating bridge and roadway are provided over the spillway section, and rails extend across the concrete dam for a gantry crane to operate the face gate and the penstock emergency gates.

On the axis of the dam, the low water width of the river is limited to about 250ft. Hydrologic and hydraulic studies by the Corps of Engineers indicated that, to protect the dam from overtopping under an extreme, but theoretically possible combination of events, the spillway should have eight Tainter gates 42ft wide by 50ft and 54ft in height. In the narrow river channel, only five 50ft high gates could be economically provided with a conventional hydraulic-jump stilling basin. The other three gates, 54ft in height, are situated on the left abutment immediately adjacent to the main spillway section. These three gates have no provisions for dissipation of energy but do incorporate a "flip bucket" near the toe of the dam so that, if and when they go into operation, the impact of the spilling water will not endanger the safety of the dam. Operation of these gates would be a rare event in any case, as even without considering the reduction of a peak by storage or surcharge, the five main gates alone can pass an uncontrolled peak inflow of about 300,000 cusecs, which theoretically may be expected about once in 500 years.

The stilling basin has been designed to prevent objectionable surges in the vicinity of the power plant for flood control releases up to 115,000 cusecs, and to contain the hydraulic jump for all spillway flows up to 300,000 cusecs. Three 15ft 6in diameter steel-lined penstocks, which are controlled by fixed-wheel emergency gates, pass through the right abutment non-overflow section to serve the power plant. The concrete river section is enveloped on both ends by large earth wings having a maximum height of 145ft, a combined length of 9000ft, and a combined volume of about 7,800,000 cubic yards. Both wing dams incorporate an impervious core with a pervious shell, separated by a transition zone of processed materials, where necessitated by grading requirements. The cut-off trench backfill and the impervious zone consist of compacted decomposed granite while the pervious shells consist of natural river gravels, dredge tailings and surplus rock from excavation. Riprap protection, from rock obtained from excavation, is provided on the water face of the wing dams. Their crest width is 30ft, and their downstream and upstream slopes are 1 in 2 and 1 in 2½, respectively. The sections were designed by the circular arc method of analysis with earthquake loading being considered.

The construction of the concrete section of the Folsom dam presented several foundation problems. The exploration of the site was difficult because of the weathered and jointed condition of the rock. Before the main dam contract was awarded, extensive exploration was carried out by core borings, and two preliminary excavation contracts were executed. These carried foundation excavation close to the expected final foundation line on the two abutments. In spite of these precautions, during construction of the main dam a number of flat-dipping weathered zones, on which some movement had taken place in the past, were encountered in the left-abutment foundation area of the concrete river section. These zones varied in thickness from a few inches to as much as 3ft, contained some residual as well as groundwater-deposited in clays, and generally dipped toward the river 15 deg. and slightly upstream. They created a time-consuming problem which was solved by removing all overlying rock down to the foot wall of the lowermost fault zone.

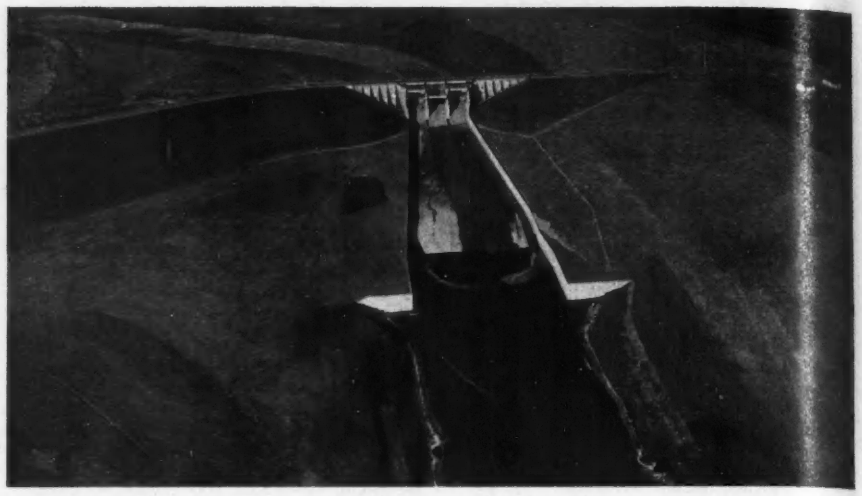


Fig. 3—Trenton dam in Nebraska is one of the flood control and irrigation structures in the Missouri River basin. It is a rolled earth-fill structure with a buttressed concrete spillway section

With regard to concrete production, aggregate from the natural gravel and dredge tailings in the American River about 4 miles downstream from the dam site had been determined to be of satisfactory quality. Because of the design requirement that concrete be placed at or below 50 deg. Fah., it was necessary to install a large refrigeration plant with a capacity of about 1000 tons of ice per day. The concrete batching and refrigeration plant is shown in Fig. 2.

In accordance with current construction schedules the concrete sections of the dam should be high enough for water storage by the dam to commence this spring. It is expected that the entire structure will be completed toward the end of this year. The first of the three 54MW Francis turbo-generators in the power station of the dam is also expected to go on the line this spring. The power station is situated on the right bank of the river, 550ft below the dam. Its power plant has been designed for a rated operating head of 300ft and its output will be fed into the grid of the Central Valley Project of the U.S. Bureau of Reclamation.

Canyon Ferry Dam

The Canyon Ferry dam, which was completed during the past year, is one of the key structures within the development scheme of the U.S. Bureau of Reclamation for the Upper Missouri District. Situated in west-central Montana, 50 miles downstream from where the Gallatin, Madison and Jefferson Rivers join to form the Missouri River, the dam now intercepts the run-off from a catchment area of about 16,800 square miles. The Canyon Ferry dam is representative of many multiple-purpose units which are being built to facilitate the economic utilisation of the land and water resources of the upper Missouri River Basin. The dam is a concrete gravity structure similar in design to the Grand Coulee Dam on the Columbia River in Washington. The dam has a crest length of 1000ft and a base width of 173ft, and is illustrated in Figs. 4 and 6. With an elevation of 3808·5ft above sea level at its top it rises 225ft above the lower extremities of the dam and 172ft above the original stream bed. The centre section is used as an overflow spillway and four radial gates, each 34ft 6in by 51ft, control the flow of water. Approximately 420,000 cubic yards of concrete were used in the dam and its appurtenant structures. Artificial cooling of the large mass of concrete was accomplished by pumping river water through 1in diameter pipes embedded in the dam, and about 126 miles of these cooling tubes were used in the dam.

Three generating units of 16·7MW each provide for an installed capacity of 50MW. The average annual output of the power station will be about 285 million kWh. Water enters the power plant from the dam through three penstocks, each 13ft 6in in diameter. Transmission facilities, which have been constructed as a part

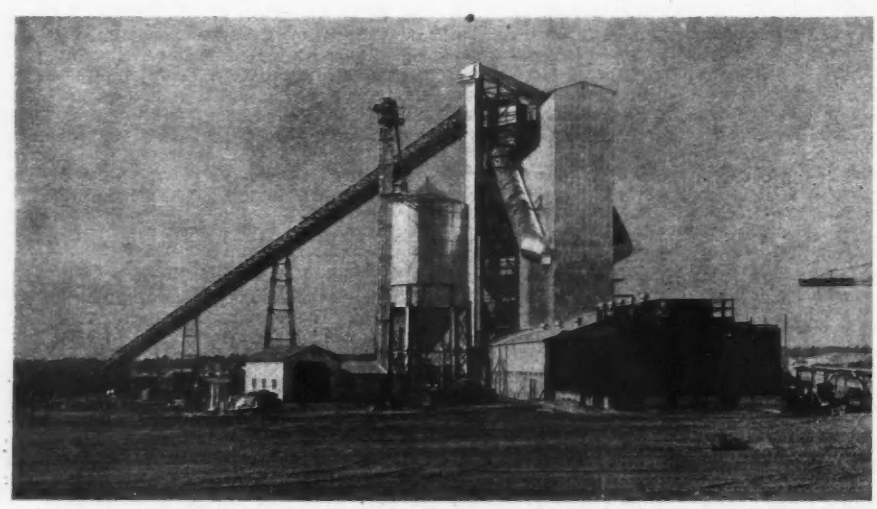


Fig. 2—Concrete batching and refrigerating plant at the Folsom dam in California

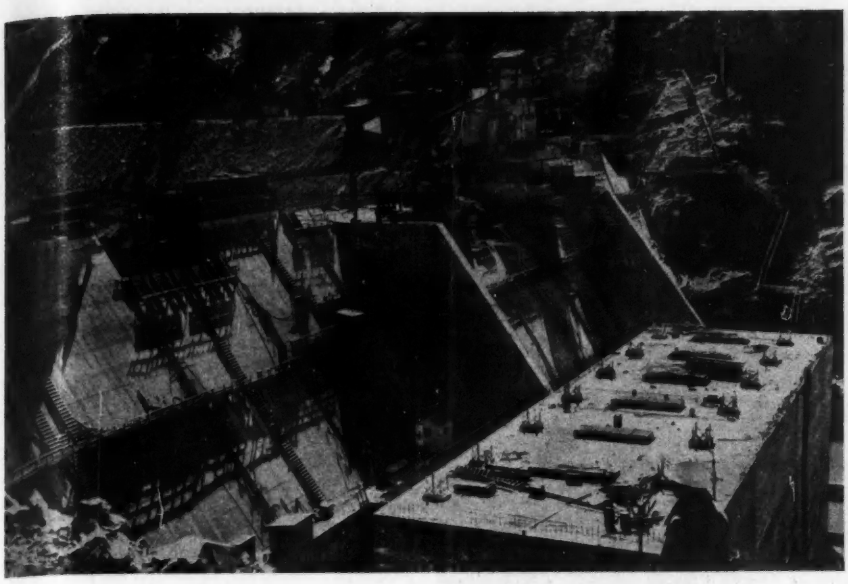


Fig. 4—Canyon Ferry dam and power station in the course of construction

of the Missouri River basin project to interconnect the federally constructed power plants, now distribute the power generated at the Canyon Ferry dam to serve existing and proposed irrigation pumping loads, rural electric co-operatives, municipalities, private utilities, and other customers. The reservoir formed by the dam extends 24 miles up the Missouri River. It has a maximum width of 4½ miles and covers 35,200 acres. The capacity of the reservoir is 2,043,000 acre-feet.

The main contract for the construction of the dam and power station was awarded in April, 1949, and completed in November, 1953. One of the most difficult aspects of construction was the site control of the flow of the Missouri River. The river channel at the site was approximately 400ft wide and 15ft deep before the start of construction. The instantaneous river flow at the site had been recorded as ranging from 280 to 33,300 cusecs. A layer of coarse sand and gravel from 30ft to 35ft deep covered the bedrock. To pass the river flow and allow for the beginning of construction of the dam, a timber and structural steel flume was built on the right side of the river. The open flume was 1000ft long and 65ft wide. The side walls of the flume were 18ft high throughout the major portion of the length, sloping to a height of 25ft at the upstream end. Two cofferdams were constructed in the river bed. The upstream dam diverted the Missouri River through the flume, and the downstream dam prevented water from flowing back into the construction area. Once construction had advanced to the stage where concrete placements were well above the high-water elevation, the cofferdams were opened and water of the Missouri River was allowed to flow through two diversion tubes and over a low block of the dam structure. This was the second-stage diversion. To exclude water from the power station area and the right portion of the dam, two new cofferdams were finally built.

Concrete placement in the dam itself began in September, 1950, and progressed at the rate of about 1000 cubic yards per day. Although the contractor planned to continue the concrete placement through the winter, it proved to be impractical. The work progressed through the 1951 construction season with no major slowdowns. During this season, the first-stage river diversion was accomplished and the river flow was directed through the two 10ft diameter diversion tubes in the dam, and early in 1952 the diversion flume was removed. Excellent progress was made during the 1952 construction season, although the river flows were the highest since construction began. The second-stage river diversion was completed early in August and by the end of the construction season 84·2 per cent of the work had been completed. Early in the 1953 construction season, heavy rains in north-central Montana drove the Upper Missouri River and many of its tributaries out of their channels and over nearly 78,000 acres of land. Even though it was still incomplete, the Canyon Ferry dam reduced the flood crest by about 7000 cusecs and shortened the peak flow of the river at Great Falls, Montana, from an estimated three days to one day.

The conservation and control of unused flood waters in the Canyon Ferry reservoir will make possible the irrigation of about 310,000 acres of new land and provide supplemental irrigation water for about 196,000 acres which are now inadequately served, all in the Missouri River basin upstream from Fort Benton, Montana. A 13ft diameter pumping intake has been installed in the dam for future irrigation use. The actual irrigation works are not part of the Canyon Ferry scheme, but will be included in other units of the Missouri River basin project.

Trenton Dam

The recently completed Trenton Dam of the U.S. Bureau of Reclamation on the Republican River in Nebraska constitutes a good example of the smaller structures which are currently being built in the Missouri River basin for sediment retention, irrigation storage and flood control; It is illustrated in Fig. 3. Its main function is to place a harness on the unstable Republican River to keep it in control and to supply water to fertile lands to increase production of foods and to ensure that production every year. The Republican River in the past has not contributed as it should to the welfare of the valley. The uncertainties of Nature and the abuse of the soil, culminating in the "dust bowl" days of the thirties and the disastrous flood of 1935, which drowned 135 people of the Republican River valley, have resulted in the area losing nearly 30 per cent of its people in the last twenty years. The catastrophic 1935 flood undoubtedly marked the end of an old and the beginning of a new era. In the thirties it was a common statement of the valley people that "Everything not washed away by the floods was blown away by the dust storms." To-day, good soil conservation practices are the rule in the valley and, with the completion of the Trenton dam, the river is being controlled and the waters are made available for irrigation.

The Trenton dam is situated on the Republican River, approximately 2½ miles west of Trenton, Nebraska. The dam is a rolled earth-fill structure, 144ft in height above shale bedrock. Storage for irrigation, silt retention, and flood control is being provided by the reservoir, which has a capacity of 364,000 acre-feet. The dam has a crest length of 8900ft and a base width of 790ft. The cut-off trench was excavated through approximately 40ft of river sands to shale bedrock. The embankment, which is placed upon this bedrock, is of impervious material compacted into place by sheepsfoot rollers. The embankment is protected from wave action and natural erosion on the upstream face of the dam by a layer of riprap placed over a layer of gravel. The downstream slope is seeded to grass. The spillway consists of a concrete structure and three radial gates and has a capacity of 133,000 cusecs. The canal outlet structure is situated on the south end of the dam. The discharge into the canal is controlled by hydraulically operated valves, which can release 300 cusecs when the reservoir is operating at a low level.

McNary Dam

The dedication of the McNary dam, one of the major multiple-purpose reclamation schemes of the U.S. Army Corps of Engineers, took place on September 23, 1954. The dam and lock of this scheme have been built on the Columbia River between the States of Oregon and Washington. The power station will ultimately comprise fourteen 70MW turbo-generators, which are scheduled for completion in 1956. The McNary dam and lock is part of a comprehensive programme for the development of the Columbia River and its tributaries. The dam structures, containing 1,850,000 cubic yards of concrete and 21,000,000 cubic yards of earthfill, extend across the valley a distance of about 7600ft. The earthfill extends from the bank on the Washington shore,

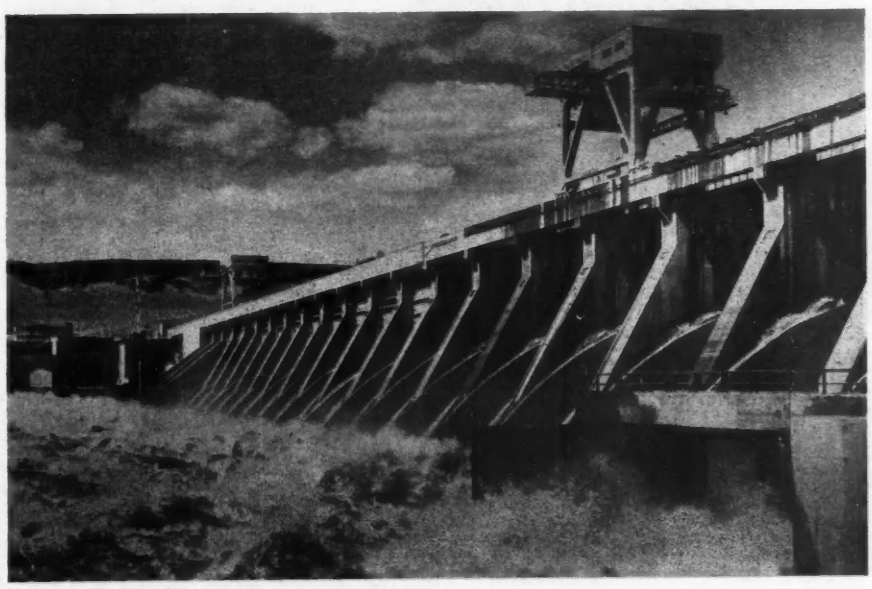


Fig. 5—The McNary dam on the Columbia River between Oregon and Washington

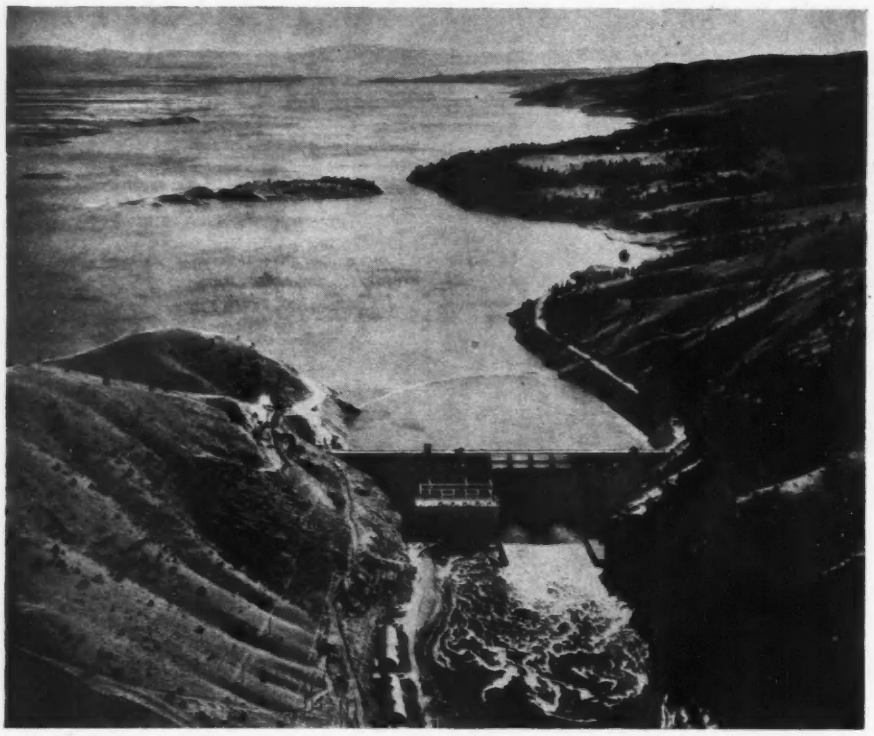


Fig. 6—Canyon Ferry dam on the Missouri River in Nebraska has a storage capacity of 2,000,000 acre-feet. Its power station has three 16·7MW turbo-generators

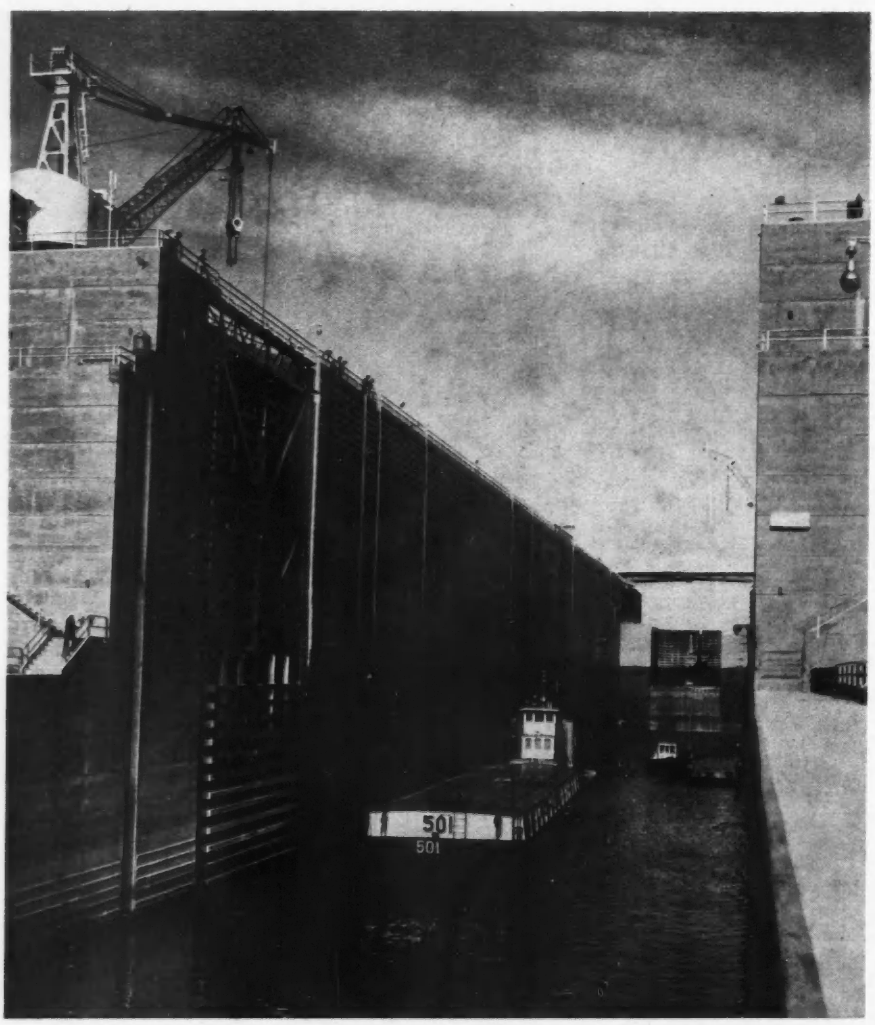


Fig. 7—Navigation lock at the McNary dam on the Columbia River. The lock is 86ft by 675ft in size and covers the entire head of the scheme—85ft in one lift

a distance of 1560ft, to join the concrete structure. The navigation lock, on the Washington shore, which is shown in Fig. 7, has clear dimensions of 86ft by 675ft and a minimum depth of 12ft over the mitre sills and covers the entire head of the scheme in a single lift. Guard walls, which are approximately 1400ft long, extending both upstream and downstream from the lock chamber, protect the river traffic from the spillway. An unconventional aspect of the lock design is the use of four sector gates in the filling and emptying culverts, with the concave faces of the gates on the pressure side. Model studies showed that far less turbulence was experienced during raising and lowering of the gates when they were placed in this manner. To provide access across the lock a double-leaf bascule bridge has been constructed. Immediately south of, and adjacent to, the lock is the non-overflow section of the dam through which the Washington shore fish ladder passes.

The spillway of the dam, which is shown in Fig. 5, extends to the south and consists of a concrete ogee section, controlled by twenty-two two-section, vertical-lift gates, 50ft wide and approximately 53ft high. The gates are operated by two 200-ton gantry cranes. A concrete stilling basin with baffles is provided downstream from the spillway. The lower sections of the gates, which are 24ft 6in high, normally remain seated on the crest of the ogee section, and the upper sections are then raised and lowered to regulate the pool level. With all gates removed the spillway is designed to pass 2,200,000 cusecs, or practically twice the maximum flood of record. Another non-overflow section of the dam, which is situated between the spillway and the power station, has an entrance to the Oregon shore fish ladder. This entrance is controlled by closed flume along the downstream side of the power station. In addition, there is a collecting and passage channel extending the full length of the power station and having a total of eighty-seven entrance openings, forty-four of them equipped with automatically operated telescopic gates. There is also an entrance at the south end of the power station.

The power station, which is situated south of the spillway, will ultimately house fourteen 70MW generators, driven at 85·7 r.p.m. by Kaplan turbines, two station service generators and an assembly bay. The dam raises the natural water surface 85ft and creates a pool extending 64 miles upstream. At the dam site the Columbia River has a mean annual flow of 190,000 cusecs, varying from an extreme low of 33,000 cusecs to the high record of 1,210,000 cusecs, which occurred in 1894. To provide for the passage of the entire flow of the river and to keep interruptions in river navigation to a minimum, construction was divided into three major stages. The first-stage cofferdam, on the Washington side, above the low-water channels, included the navigation lock, the north non-overflow section, the Washington shore fish ladder, and thirteen and a half bays of the spillway. The second stage provided for a cofferdam on the Oregon shore adjacent to the main channel above low water, for construction of the south end of the power station substructure, comprising two main unit bays, station service and assembly bays, and the intake structure for that part of the station. The third and final stage included the construction of (1) twelve main unit bays of the power station substructure and intake structures for these bays ; (2) the entire power station building ; (3) the south non-overflow section of the dam ; (4) eight and a half bays of the spillway within the main second-stage cofferdam, and raising the ogee section of the partially completed spillway bays ; (5) completion of the upstream sill block of the navigation lock ; (6) completion of the fish ladder on the Oregon shore, and (7) completion of embankments on both the Washington and Oregon shores. The pool was raised to its minimum operating level in the spring of 1953 on completion of the ogee crest of the spillway and the sill block of the navigation lock.

On December 15, 1953, the English Electric Company, Ltd., received a contract to supply the last of the fourteen generators for the McNary project. Another British firm, Ferranti, Ltd., has received a contract to supply six large transformers for this scheme.

Industrial and Labour Notes

Railway Wages

On Thursday evening of last week, the National Union of Railwaymen announced that it had withdrawn the notices issued to its 400,000 members throughout the country to begin a strike at midnight on Sunday, January 9th, over the wages dispute. This decision came at the end of two days' discussion following the presentation to the Minister of Labour of an interim report of the Court of Inquiry which was set up to examine the circumstances of the dispute.

During those two days, Wednesday and Thursday of last week, the Minister of Labour had conversations with N.U.R. officials and with representatives of the British Transport Commission, and ultimately it was agreed that negotiations between the Commission and the N.U.R. should be resumed immediately. These fresh negotiations began on Friday and by the end of that day it was announced that the wages of the lower grades of adult male railway workers belonging to the N.U.R. were to be increased by from 6s. to 8s. a week as from Monday last. This arrangement includes a higher minimum "starting" rate with increases in the second and third years of continuous service. The N.U.R. had threatened its strike action in support of a demand for increases which would bring the wages of its members to 15 per cent above the rates ruling prior to December, 1953. The increases agreed upon last Friday are between 13s. 6d. and 17s. 6d. higher than the 1953 rates and are virtually in line with the union's demand. At the same time, it was agreed that the wage rates for other grades of railwaymen would be considered as expeditiously as possible, and negotiations to that end between the three railway unions and the British Transport Commission began on Tuesday last.

The interim report of the Court of Inquiry criticised the British Transport Commission for maintaining, during the earlier negotiations, that even if claims for increased wages were recognised as valid and desirable they could not be met or conceded because of a financial bar which in the Commission's view was imposed by the statute under which it operated. The report said that the argument used by the Commission in past negotiations that it found itself unable to pay rates which it might agree to be proper, because it was prevented from so doing by certain terms of its financial constitution, was not only undesirable in this nationalised industry but was "unsound in the light of the figures provided by the Commission and should not be repeated." In what it called a statement in the "plainest of terms," the Court said that the nation had provided by statute that there should be a nationalised system of railway transport, which must therefore be regarded as a public utility of the first importance. Having willed the end, the Court observed in its report, the nation must will the means, which implied that employees of such a national service should receive a fair and adequate wage and that, in broad terms, the railwayman should be in no worse case than his colleague in a comparable industry. The report also criticised the National Union of Railwaymen for rejecting, particularly whilst it was being operated, the agreement which had been negotiated and ratified on October 8th last. The executive of the N.U.R. further erred, the report said, in refusing to enter into fresh negotiations except on the basis that they should be regarded as a continuation of the claim for a 15 per cent increase, originally submitted in July, 1953, and on condition that the British Transport Commission should give, in anticipation, a guarantee that it would grant a substantial part of that claim. Finally, the Court expressed its view that there was a case for "a critical re-examination of all wage rates for conciliation staff covered by the agreement of October 8, 1954."

Employment and Unemployment

A report by the Ministry of Labour on the employment situation in Great Britain states that, at the end of November last, there were 22,685,000 people (15,025,000 men and 7,660,000 women) in civil employment. This was 50,000 more than at the end of October.

An analysis of the figures for civil employment shows that in the basic industries there were 3,954,000 people at work at the end of November, which was 22,000 less than a month earlier. In the manufacturing industries, 9,234,000 people were employed, or 39,000 more than in the preceding month. In the basic industries, most of the decrease in employment in November occurred in agriculture and was no doubt seasonal. There was no change in the figures for mining and quarrying, the number of wage earners on colliery books being 704,000 or 1000 fewer than the total at the end of November, 1953. In the manufacturing industries, the biggest addition during November was in the labour force of the group classified as "engineering, metal goods and precision instruments." At the end of the month, the total number employed in that group was 2,720,000, which indicated an increase of 19,000 since the end of October, and was 117,000 more than at the end of November, 1953. In vehicle manufacturing, there was an addition of 7000 during November to the number of people employed which brought the total to 1,204,000, compared with 1,152,000 a year earlier. The principal employment changes in November in other industries and services were in building and contracting, in which the number at work fell by 3000 to 1,422,000, and in "professional, financial and miscellaneous services," where there were 3,977,000 people engaged, or 10,000 fewer than at the end of October.

The latest unemployment figures issued by the Ministry of Labour relate to December 6th, when the number of people registered as out of work was 256,308, or 6751 fewer than on November 15th. It is estimated that the December figure represented 1·2 per cent of the total number of employees. In its report the Ministry says that in the week ended November 27th last, about 30,000 operatives in manufacturing establishments were on short time, losing about twelve hours each on the average; on the other hand, there were in the same week about 1,690,000 operatives who were working an average of eight hours' overtime.

Coal

At the end of last week, Sir Hubert Houldsworth, chairman of the National Coal Board, issued a statement reviewing the industry's performance in 1954. Sir Hubert said that the output of deep-mined coal was 213,551,000 tons, which was an advance on the preceding year of 1,730,000 tons, and that from opencast workings 10,240,000 tons had been gained, which was 1,460,000 tons less than in 1953. The total production for last year was therefore 223,790,000 tons, an increase of 27,000 tons over the preceding year. Six divisions, Sir Hubert continued, last year produced a greater output than in 1953 when there was one working day less. Output resulting from the voluntary overtime shift worked on Saturday mornings amounted to 11,900,000 tons last year and was a little above the record for 1953. The decline in opencast production, Sir Hubert said, had been a factor outside the Coal Board's control and had been due to delay in obtaining the necessary site clearances. It was expected, however, that as a result of recent discussions clearances would be effected more quickly. The exceptionally bad weather during the summer and autumn of last year had also adversely affected opencast output.

Sir Hubert then went on to discuss productivity in the mines. In 1954, he said, output a man-year at the face was 735 tons, compared with 726 tons in 1953, and the overall output was 302 tons, an increase of 4 tons on the 1953 figure. Output per manshift at the face, at 65·2 cwts, was also higher last year than ever before. The weekly manpower average in the mines last year was 707,200, compared with 712,900 in 1953, the number of face workers averaging 290,400 and 292,800 in the years 1954 and 1953, respectively. Sir Hubert explained in his statement that after an overall gain of 5000 in the first four months of last year, manpower fell continuously until shortly before Christmas, and the coal mining industry finished the year with 704,700 wage earners on the books. There were welcome rises in manpower during the year in the East Midlands and West Midlands, but in five other divisions manpower fell. In some of these divisions, Sir Hubert stated, this decline was partly a result of the Board's policy of attracting trained men into the North Eastern and West Midlands divisions, where the capacity for worthwhile expansion was high, but where the competition for manpower was most severe.

Competition for labour during the current year, Sir Hubert thought, was likely to be keen, though the Board was hopeful that its latest campaign would attract labour, particularly inexperienced recruits, and as far as possible to the deficiency areas of Yorkshire, the West Midlands and parts of South Wales. The number of men employed on reconstruction, development and other special work, many of whom were experienced coalface workers, had risen steadily since vesting day, and last year about 1000 more had been engaged on this work than in 1953. Sir Hubert then referred to deep-mined output lost through disputes during 1954. It was estimated, he said, that the amount was 1,220,000 tons, which figure did not include losses caused by "restriction of effort." The amount was larger than in 1953, although, Sir Hubert said, there were no big stoppages of work last year.

Sir Hubert ended his statement by referring to coal usage. Last year, he said, inland consumption had risen by 6,000,000 tons to a total of 213,500,000 tons. By the end of the year, approximately 2,900,000 tons of coal had been imported from Europe and the U.S.A. The continued expansion of industrial production, Sir Hubert observed, was the main reason for the increase, though the colder weather last year probably accounted for 2,000,000 tons. The largest increase of coal consumption was of nearly 3,000,000 tons by power stations, despite a saving of about 1,000,000 tons through improved generating efficiency.

Careers Booklets

Two new illustrated booklets in the "Choice of Careers" series issued by the Central Youth Employment Executive, have been published this week. One is entitled *The Sheet Metal Worker*, which describes the varied work done by the sheet metal worker and the different methods he uses. There are separate sections on preparing for a job, shaping the article and sheet metal jointing. Other sections are devoted to training, technical studies, prospects of promotion, wages, hours and conditions and openings in the Industrial Civil Service and in the Forces. The other booklet is entitled *Engineering Draughtsman*. It describes "a kind of job likely to appeal to boys of quiet temperament and neat hand, who enjoy art lessons, perhaps more than others," but who show "an aptitude for mathematics and the sciences, with a practical way of thinking." The booklet tells of the work of the engineering draughtsman, the kind of technical problems it presents, the opportunities it offers and the qualities and qualifications it demands.

These booklets are two of a group in the series dealing with the various occupations in the engineering industry. They are intended primarily for boys who are about to decide what to do on leaving school, but they may also be of interest to parents, teachers and others who are concerned in helping young people to make a wise choice of career. The booklets are obtainable from H.M. Stationery Office, price 1s. 3d. and 1s., respectively.

Personal and Business

Appointments

MR. DUDLEY THOMAS has joined the sales staff of C.A.V., Ltd., Acton, London, W.3.

MR. D. LEIGHTON DAVIES has been appointed chief electronic engineer of Winston Electronics, Ltd., Hampton Hill, Middlesex.

MR. L. F. PARSONS has been appointed technical sales representative, in the London area, of Jenolite Ltd., 13–17, Rathbone Street, W.1.

MR. H. LUNDY has been appointed head of the technical service department in the "Oxylene Boram" division of the Timber Fireproofing Company, Ltd.

MR. R. T. HILL has been appointed sales director of Export Packing Services, Ltd., 56, Kingsway, London, W.C.2, in place of Mr. P. A. Andrew, who has retired on account of ill-health.

MR. JOHN A. GRACE has been appointed commercial manager of Folland Aircraft, Ltd., Hamble, Southampton. Since 1940 he has been contracts manager of The de Havilland Aircraft Company, Ltd.

MR. C. F. J. FRANCIS-CARTER has been appointed managing director of Aluminium Wire and Cable Company, Ltd., Port Tennant, Swansea. He has been general manager of the company since its inception in 1947.

MR. F. E. DEBENHAM has been appointed manager of the service department of the valve division of Mullard, Ltd., in succession to Mr. E. B. Rogers, who has retired after twenty-eight years' service in that position.

MR. A. J. HEYWORTH has been appointed chief test pilot of Rolls-Royce, Ltd., Derby, in succession to Mr. H. N. D. Bailey, who has become manager, technical administration. Mr. H. C. Rogers has been appointed Mr. Heyworth's assistant.

THE MINISTRY OF TRANSPORT AND CIVIL AVIATION announces the appointment of Mr. A. M. Daniels as principal officer in the east of England district, Hull, of the Marine Survey Service. Mr. Daniels succeeds Mr. R. J. Shepherd, who has retired.

MR. T. ALLEN has been appointed an administrative director of G.W.B. Furnaces, Ltd., Dibdale Works, Dudley. He joined the company in 1934 and has been general manager since 1948. Mr. A. V Francis has been appointed chief engineer, with responsibility for furnace design and sales.

LONDON TRANSPORT announces the following appointments in the department of the chief mechanical engineer (road services): Mr. C. B. Clapham, A.M.I.Mech.E., assistant to the chief mechanical engineer (road services); and Mr. A. G. Higgins, A.M.I.Mech.E., principal executive assistant.

DR. R. J. SARJANT, F.I.M., has been appointed director of research of the British Steel Castings Research Association, Broomgrove Lodge, Sheffield, 10. Dr. A. H. Sully, at present head of the metallurgy division of the Fulmer Research Institute, has been appointed associate director of research of the British Steel Castings Research Association.

W. H. ALLEN, SONS AND CO., Ltd., Queen's Engineering Works, Bedford, announces the appointment of Mr. J. R. Bryant as head of the laboratory. He was formerly deputy chief metallurgist, and in his new appointment succeeds Mr. R. T. Rolfe, F.I.M., who has now retired. Mr. Rolfe will continue his association with the company as a consultant.

THE NATIONAL INDUSTRIAL FUEL EFFICIENCY SERVICE announces the appointment of Mr. C. A. J. Plummer as area engineer for Wales, in succession to Mr. G. H. Barnard, who is taking up an appointment at the N.I.F.E.S. headquarters in London. Mr. H. H. Grattridge has been appointed area engineer for Scotland, and Mr. W. Short becomes deputy area engineer.

THE ENGLISH ELECTRIC COMPANY, Ltd., announces the appointment of Mr. R. H. Bannister as manager of the home branch organisation at Stafford. For the last ten years Mr. Bannister has been manager for Scotland and Ireland. Mr. P. McNee has been appointed manager in the Scottish territories, and Mr. W. M. Todd succeeds him as manager at the Edinburgh office.

MR. A. DE M. BROWNE, managing director of Hackbridge and Hewittic Electric Company, Ltd., Walton-on-Thames, Surrey, has been appointed chairman of the company. Mr. Browne, who joined the former Hewittic Electric Company, Ltd., in 1924, is a director of New Switchgear Construction Company, Ltd., and president of the Hackbridge and Hewittic Electric Company of Canada, Ltd.

MR. BERTRAM WHITE has been appointed managing director of A. Boake, Roberts and Co., Ltd., Stratford, London, E.15, on the retirement from the office of Mr. F. G. Pentecost. Mr. Pentecost will continue to serve as chairman. Mr. J. A. Pentecost has been appointed a director, and Mr. T. A. Mason has joined the company as general works manager of the Stratford, Rainham and Letchworth factories.

SUNVIC CONTROLS, Ltd., 10, Essex Street, Strand, London, W.C.2, announces the appointment of Mr. G. G. Harris, 20, Lawn Road, Rowley Park, Stafford (telephone, Stafford 1764), as Midlands representative for process control. Mr. G. R. Peeke, 117, Stratford Road, Birmingham, 11 (telephone, Birmingham Victoria 1076), is the company's Midlands representative for scientific and industrial instruments.

Business Announcements

SIR HUGH WARREN has retired from his position as managing director of Associated Electrical Industries, Ltd.

G. W. B. FURNACES, Ltd., states that its head office is to be transferred on February 1st to Dibdale Works, Dudley.

STANDAGE POWER COUPLINGS, Ltd., has now moved its works to Telscombe Cliffs, Newhaven, Sussex (telephone, Peacehaven 2335).

MR. R. A. SEFTON JENKINS, A.M.I.C.E., states that his business address is now 66, Victoria Street, London, S.W.1 (telephone, Tate Gallery 9605).

BURTON GRIFFITHS AND CO., Ltd., states that all its stocks of small tools and engineering equipment are now centralised at the headquarters of the small tools division at Montgomery Street, Birmingham, 11.

DUNLOP, Ltd., states that Mr. Norman G. Thomas has retired from his position as manager of the machine tool division at Fort Dunlop. He has held that post since 1947, having joined the company in 1919.

MR. C. C. WALKER has retired from the board of The de Havilland Aircraft Company, Ltd. He was a founder director when the company was formed in 1920, having joined its predecessor, The Aircraft Manufacturing Company, Ltd., in 1915.

MR. ROBERT F. EARLEY, A.M.I.C.E., informs us that he now has a London office at 4, Curzon Place, W.1 (telephone, Grosvenor 5111). In future, he will collaborate as an associated consultant with Messrs. Bolton, Hennessey and Partners of the same address.

LANCASHIRE DYNAMO AND CRYPTO, Ltd., Trafford Park, announces the retirement of Mr. H. P. Pentelow, after fifty-one years' service. For practically the whole of his period of service, Mr. Pentelow has been concerned with the electrical operation of heavy machine tools.

WEATHERFOIL HEATING SYSTEMS, Ltd., Slough, Bucks, has been appointed sole sales and servicing agent in the United Kingdom for "Dravo" industrial space heaters, which are manufactured under licence in this country by Coventry Radiator and Presswork Company, Ltd.

THE BRITISH OXYGEN COMPANY, Ltd., announces that a new company, British Oxygen Linde, Ltd., has been formed in conjunction with Gesellschaft für Linde's Eismaschinen A.G. of Wisbaden, Germany. This concern will provide a joint selling company for handling the air separation and gas separation plant of the two firms in the United Kingdom and overseas. The headquarters of the new firm will be Bridgewater House, Cleveland Row, London, S.W.1. It will have two British directors—Mr. F. J. Clark and Dr. P. H. Sykes—and two German directors, Mr. P. Ruckdeschel and Dr. J. Wucherer.

Contracts

METROPOLITAN-VICKERS ELECTRICAL EXPORT COMPANY, Ltd., has received an order for power plant with a total output of 142·500MW for installation on the south coast, in Majorca, and in Spanish Morocco. The contract, the value of which approaches £2,000,000, forms part of a big power development scheme in Spain, organised by the Instituto Nacional de Industria. Six steam turbo-generator sets are to be supplied, together with condensing, feed heating and evaporating plant. Four sets are rated at 30MW (two for Cadiz, one for Almeria, and one for Malaga), one at 15MW (for Palma de Mallorca), and one at 7·5MW (for Ceuta). Single-cylinder turbines will be used throughout; the 30MW machines operate with inlet steam at 850 lb per square inch gauge, 900 deg. Fah., and cooling water at 80 deg. Fah., while for the smaller turbines the figures are 600 lb per square inch gauge, 825 deg. and 68 deg. Fah. The four larger generators (each rated at 37·5MVA) are hydrogen-cooled and will generate at 11·8kV, the 15MW and 7·5MW machines (air cooled) will generate at 5·2kV and 15kV respectively. All this equipment will be made at the Metropolitan-Vickers works at Trafford Park, Manchester, and Germiston, Glasgow. The first of the 30MW sets and both the smaller units are planned for commissioning in the spring of 1957.

Miscellanea

CEMENT PRODUCTION IN 1954.—Cement production has averaged in 1954 a rate of a million tons a month for the first time. The total production exceeded that for 1953 by some 750,000 tons, an increase of rather more than 6½ per cent.

"ELECTRICAL PLANT FOR POWER GENERATION."—A brochure entitled "Electrical Plant for Power Generation" has been published by the General Electric Company, Ltd. This publication illustrates and describes air-cooled alternators of 20MW and upwards, hydrogen-cooled alternators of 50MW and upwards, and their associated equipment, with particular reference to the hydrogen cooling system, its auxiliaries and its controls. There are separate descriptive sections on the electrical protection of generating plant, supervisory equipment, pump motors and automatic systems of control for boiler-house auxiliaries.

"BUILDING IN CONCRETE" EXHIBITION.—The "Building in Concrete" Exhibition, which was held at the Royal Institute of British Architects in October, has been shown at a number of other cities in Britain. It will be on view at the Building Centre, Store Street, London, from January 17th to January 29th inclusive. When the exhibition is finally dismantled copies of the photographs will be kept for inspection in the Library of the Cement and Concrete Association. Whenever photographs of outstanding concrete structures come to hand, it is stated, they will be added so that the collection will become a permanent reference for architects and engineers.

CONFERENCE ON "ELECTRONICS IN INDUSTRY AND COMMERCE."—During February the South Wales Electricity Board will be holding a conference on the above subject at Swansea and Cardiff. The dates and venues of the conferences are: Patti Pavilion, Swansea, February 2, 3 and 4, 1955; Drill Hall, Dumfries Place, Cardiff, February 16, 17 and 18, 1955. Films depicting general and particular applications of electronics will be shown and a complete range of industrial and commercial electronic equipment, including many working exhibits, will be displayed. A talk and discussion on "Electronics in Industry and Commerce," will be introduced by Mr. W. P. Warren.

MR. R. O. HERFORD.—We regret to record the death of Mr. R. O. Herford, O.B.E., which took place at Buenos Aires on January 2nd. Mr. Herford, who retired from the office of managing director of the Renold and Coventry Chain Company, Ltd., in March, 1953, continued as a member of the board and was on a visit to the company's agents when he died. He was associated for forty-six years with the company and its predecessors and entered the employment of Hans Renold, Ltd., as an apprentice in 1909, becoming works director ten years later, and general works manager following the merger of Hans Renold, Ltd., The Coventry Chain Company, Ltd., and Brampton Brothers, Ltd., in 1931. He assumed the post of managing director in 1944 and continued in this position until 1953.

BRISTOL "ORPHEUS" TURBO-JET.—The Bristol Aeroplane Company has announced that the new Bristol "Orpheus" lightweight turbo-jet engine has started its running trials. The first run of the new engine was achieved within a year of the start of the detailed design. During these twelve months all main components were subjected to rig testing and much of the development work normal to all new engines has already been accomplished. What is stated to be a remarkably low measured weight is an improvement upon the first design estimates and has been obtained without any sacrifice in life or reliability. Unlike some other small-sized turbo-jets, the "Orpheus" is not designed as an expendable unit. The "Orpheus" has been expressly designed for light fighters, trainers and other aircraft requiring a medium-thrust lightweight engine. No particulars of power or details of the design may yet be published.

LINK BETWEEN WEST GERMANY AND CABLE SYSTEM OF CABLE AND WIRELESS, LTD.—Direct communication, by cable and landline, is now open between Cable and Wireless, Ltd., stations at Carcavelos, Portugal, and Vigo, Spain, and the Deutsch Atlantische Telegraphengesellschaft stations at Hamburg and Emden, West Germany. The circuit includes a direct cable link of 1·132 nautical miles between Vigo and Emden. It will link West Germany with South America and other countries, by way of Vigo and the world-wide cable system of Cable and Wireless, Ltd. To operate the circuit at the West German end, a complete set of C. and W. cable telegraph equipment is installed at the Deutsch Atlantische Telegraphengesellschaft's stations at Hamburg and Emden. The equipment is of the kind used at the C. and W. cable stations, and includes regenerators, magnifiers, relays and direct printers. The first cable between Vigo and Emden was laid in 1896. Extensive renewals were carried out in 1929, and the link was interrupted in 1939. The cable was restored by D.A.T. during the early part of 1954.

British Patent Specifications

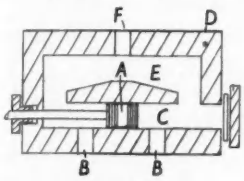
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

INTERNAL COMBUSTION ENGINES

720,661. February 4, 1953.—AN ENGINE CYLINDER CUT-OUT DEVICE, Sydney Cargill, 229, Acheson Road, Shirley, Birmingham.

The invention relates to devices for raising or lowering the power obtained from multi-cylinder engines of motor vehicles by cutting out or bringing into operation one or more cylinders. Its object is to lessen fuel consumption by cutting out one or more cylinders on light load, and bringing into operation all cylinders on full load. The drawing shows the device as designed for a four-cylinder engine, and the piston *A* is shown in its central position leaving both



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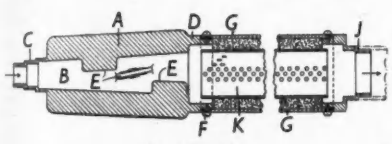
outlets *B* open to supply combustible mixture to all four cylinders; each outlet connects with the intake passage *C* and with a separate passage in the intake manifold feeding a pair of cylinders. A pair of cylinders may be shut off by moving the piston over one of the outlets *B*. The invention consists of a body *D* which on motor vehicle engines is fitted between the carburettor outlet and the engine intake manifold. A pair of passages *E* and *C* are provided in the body of the device having an inlet port *F* for connection to the carburettor; outlet ports *B* are provided from the passage *C* for connection to the separate passages in the engine intake manifold, each of which feeds a separate cylinder or group of cylinders. The double-ended sliding piston *A* can be moved to cover one of the outlet ports *B*.—*December* 22, 1954.

720,711. February 14, 1953.—EXHAUST SILENCERS, Florence Crowley, Daisy Bank Farm, Crow Tree Lane, Bradford.

The silencer, as the drawing shows, comprises a lower exhaust gas expansion chamber and an upper muffling chamber. The lower part consists of an exteriorly flanged or finned body *A* with a central bore *B*, which tapers from the inlet to the outlet end. At the inlet end is a projecting tube *C* having different external diameters and the outlet end consists of a projecting annular ring or boss *D*. Set at angles within the passage *B* are a series of fins *E*,



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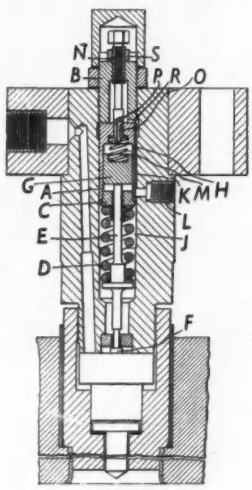
which impart a helical action to the exhaust gases. Secured to the boss *D* by screws *F* is the muffling chamber consisting of an outer casing *G* whose outlet end has secured to it a cap *J* with different external diameters. Axially arranged in the casing *G* is a perforated pipe *K* surrounded by a lagging of sound-absorbing material such as steel wool or glass wool. Exhaust gases entering the inlet end of the silencer expand within the tapering passage *B* of the expansion unit have a helical action imparted and are cooled by the action of the exterior fins of the body *A*, the gases subsequently passing to the outlet end of the muffling chamber, where the noise is silenced by the sound-absorbing material.—*December* 22, 1954.

720,011. August 24, 1951.—LIQUID FUEL INJECTION EQUIPMENT, David William Edgar Kyle, 19, Park Road, Chiswick, London, W.4. (Communicated by Kockums Mekaniska Verkstads Aktiebolag, Malmo, Sweden.)

In addition to the spring loading of the fuel needle valve of the injector in this equipment the opening of the valve is also resisted by a dashpot which appreciably slows down its opening movement and thus causes the fuel to be injected at a rate which is at first low but then rises. Referring to the drawing, a dashpot *A* is interposed between the usual spring adjusting screw *B* and the outer spring collar *C* for the injection valve spring *D*, the collar bearing against the mouth of the dashpot cylinder. A rod *E* which transmits the spring pressure to the injection valve needle *F* is extended out through the spring *D* and through a clearing hole in the outer spring collar *C*, and at its outer end abuts the face of a dashpot piston *G*. A fine bore *H* leads through the wall of the dashpot cylinder into the internal space of the injector body *J*, conveniently by way of a keyway *K* in the dashpot cylinder wall. The tip of a guide screw *L* prevents the dashpot cylinder from rotating when the spring adjusting screw *B* is turned. When the injection needle valve is lifted by the pressure of the fuel, the dashpot resists its opening movement and causes the fuel to be injected at a



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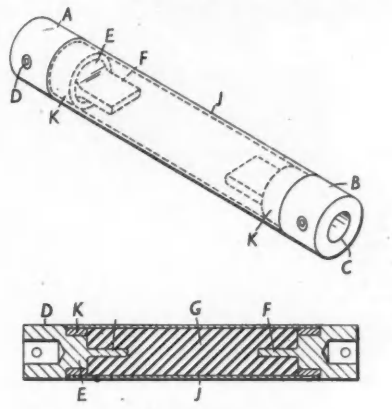
rate which is at first slow but then rises. The needle valve is free to close promptly, uncontrolled by the dashpot, as the outer end of the rod *E* can leave the dashpot piston to follow the rod under the action of a comparatively light spring *M* between the dashpot cylinder head and piston. Thus no separate valve for refilling the dashpot is necessary as the time available enables it to refill through the fine bore *H*. The working fluid in the dashpot is fuel, the whole of the space within the injector body *J* being filled by leakage past the needle valve *F*. A dashpot as described, having only a fixed bore *H*, is best suited to engines which run within a fairly small speed range. Adjustment of the passage giving the dashpot effect is desirable for engines having a considerable speed range, but may be a convenience even with engines with a small speed range. The drawing also shows such an adjustment. A screw *N* through the screw *B* fits in the head of the cylinder *A* and has a bore *O* permanently open to the cylinder and opening at *P* in its side. When the screw *N* is screwed right in, the opening *P* is covered by the cylinder head, but by unscrewing a gradually increasing area of the opening *P* can be uncovered. From *P* the fuel in the dashpot escapes through a bore *R* in the screw *B* to the keyway *K*. The bore *H* is still retained and serves to determine the minimum passage for the fuel into or out of the dashpot. A locknut *S* is provided to lock the screw *N* in its adjusted position. Alternative designs are also shown in the specification.—*December* 15, 1954.

POWER TRANSMISSION

720,404. February 19, 1952.—POWER TRANSMISSION COUPLINGS, Dunlop Rubber Company, Ltd., 1, Albany Street, London, N.W.1. (*Inventor: Paul Brierley.*)

As the drawing indicates, the coupling comprises two spaced coaxial cylindrical metal members *A*, *B*, each having an outer radial face with a blind hole *C*. A locking screw *D* passes through the wall of each member into the hole. The face of each member opposite the hole is provided with an axial spigot *E* of reduced diameter. From the transverse face of the spigot there projects a blade *F*. A solid cylindrical block *G* of natural or synthetic rubber is located between the metal members *A*, the end face of the block abutting the end faces of the spigots *E*. Axial slots are provided in the end faces of the block for the reception of the blades *F*. A thin cylindrical metal cover *J* surrounds the block. A suitable lubricant, such as silicone fluid, is introduced between the inside of the cover and the surface of the rubber block to prevent fretting of the rubber, the surface tension of the fluid being sufficiently high to maintain a thin film between the cover and the block. The ends of the cover *J* overlap the spigots *E* on the rigid members and are supported by antifriction self-lubricating bearings *K* on the spigots. The cover is located endwise by the rigid members and is freely rotatable with respect to the block and the rigid members. In operation the ends of driving and driven coaxial shafts are secured within the holes in the rigid members by the locking screws *D*. Drive



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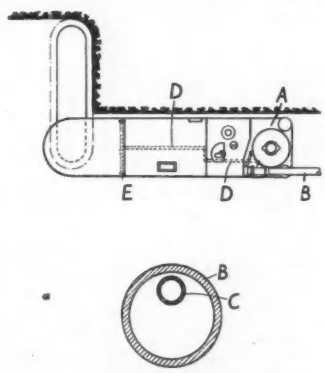
from the shaft is transmitted through the rigid member *A* and the blades and the rubber block to the other rigid member *A* and the driven shaft. Owing to the resilience of the block a degree of torsional flexibility is obtained between the two shafts. The cover member prevents a displacement of the rubber block in a radial direction and consequent lateral deformation of the coupling.—*December* 22, 1954.

MINING ENGINEERING

720,638. September 17, 1952.—SUPPLYING WETTING LIQUID TO COAL GETTING MACHINES, Gebr. Eickhoff Maschinenfabrik u. Eisengiesserei m.b.H., of Bochum, Germany.

The invention relates to means for supplying a wetting liquid to power-driven coal getting machines in order to avoid or reduce the danger of coal dust.



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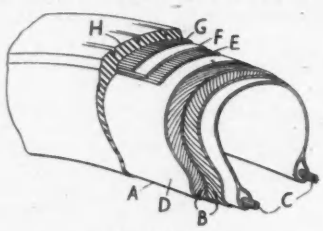
Referring to the drawing, a coal cutter having a haulage winch disposed at the body end *A* is provided with compressed air by a pipe *B* and with a wetting liquid by a conduit *C* which is disposed within the pipe *B*, as shown in the lower view. The combined pipe and conduit are connected to the machine by a flexible tube *D* which extends from the end *A* through the body and opens to a spray pipe *E* which extends parallel with the chain cutter jib. Further details of the pipe connections to the machine are given in the specification.—*December* 22, 1954.

ROAD TRANSPORT

720,150. March 3, 1953.—PNEUMATIC TYRES, Dunlop Rubber Company, Ltd., a British company, 1, Albany Street, London, N.W.1. (*Inventors: David Henry D'Oyly Cooper and Paul Brierley.*)

The object of the invention is to provide a pneumatic tyre cover having a rigidly reinforced tread which is effective in limiting the tread movement and reducing tread wear. As will be seen from the drawing, the tyre comprises a light carcass *A* made of a rubber foundation sheet and of two layers of rubberised textile cords *B* wrapped around a pair of tyre beads *C*, the cords in each layer being mutually parallel and inclined in the opposite direction to the cords in the other layer, both sets of cords making an angle of 80 deg. with the tyre beads. A sheet

of rubber *D* is wrapped circumferentially around the crown of the carcass and a single layer of parallel rubberised steel cords *E* is wrapped circumferentially around the crown and over the rubber sheet. A



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sheet of nylon *F* is wrapped over the steel cord winding. A second layer of parallel rubberised steel cords *G* is wrapped around the crown so as to sandwich the sheet *F* between two layers of steel cord. A conventional rubber tread and side-wall *H* is then applied and the whole assembly vulcanised.—*December* 15, 1954.

Launches and Trial Trips

HELCION, oil tanker ; built at the Wallsend Shipyard of Swan, Hunter and Wigham Richardson, Ltd., for Shell Tankers, Ltd.; length between perpendiculars 530ft, breadth moulded 69ft 3in, depth moulded 39ft, deadweight 17,910 tons on 29ft 9½in draught, service speed 14¼ knots ; one main cargo oil pump room, four 400 tons per hour turbine-driven cargo pumps, two stripping pumps, steam deck machinery ; two 550kW turbine-driven alternators, one 200kW diesel-driven alternator ; B.T.H. propelling machinery, consisting of two turbine-driven alternators and a propeller motor of 7500 s.h.p. at 100 r.p.m., steam supplied at 450 lb per square inch and 750 deg. Fah. by two Babcock and Wilcox boilers built by the Wallsend Slipway and Engineering Company, Ltd. Trial, December 16th.

DORESTAD, oil tanker ; built by the Netherlands Dock and Shipbuilding Company for N.V. Amsterdamse Olietransport Maatschappij ; length between perpendiculars 532ft 6in, breadth moulded 72ft 9in, depth 38ft 3in, draught summer freeboard 29ft 6in, deadweight 18,500 tons ; twenty-seven cargo oil tanks ; Stork single-acting, two-stroke diesel engine, eight cylinders, 750mm diameter by 1500mm stroke, 7500 b.h.p. at 118 r.p.m. Launch, December 18th.

VASSILIKI, oil tanker ; built by the Furness Shipbuilding Company, Ltd., for Nueva Vista Compania Naviera S.A. Panama ; length overall 525ft 1in, length between perpendiculars 496ft, breadth moulded 67ft 6in, depth moulded 36ft 5in, draught 29ft 0⅛in, deadweight 16,160 tons ; twenty-seven cargo oil tanks, one main pump room, three 500 tons per hour cargo oil pumps, and one 150 tons per hour stripping pump ; steam deck machinery, two 60kW steam-driven generators ; Hawthorn-Doxford single-acting, two-stroke oil engine, five cylinders, 670mm diameter by 2320mm combined stroke, 5500 b.h.p. at 115 r.p.m., two Scotch boilers. Trial, December 20th.

CANOPIC, refrigerated cargo ship ; built by Vickers-Armstrongs, Ltd., at Walker Naval Yard, for Shaw Savill and Albion Company, Ltd.; length between perpendiculars 481ft, breadth moulded 69ft, depth moulded to upper deck 33ft 4¼in, draught loaded 30ft 4¼in, deadweight 11,390 tons, gross tonnage 11,166 tons, insulated cargo 348,280 cubic feet, general cargo (bale) 308,635 cubic feet ; six holds and 'tween decks ; trial speed 18¼ knots ; two Harland and Wolff six-cylinder oil engines, 14,300 b.h.p. Trial, December 22nd.

Catalogues

CROFTS (ENGINEERS), Ltd., Bradford, 3.—Publication describing cast iron conveyor pulleys.

J. H. FENNER AND CO., Ltd., Hull.—Booklet describing torque-arm shaft-mounted speed reducers.

THE PLESSEY COMPANY, Ltd., Ilford, Essex.—Catalogue describing linear and rotary actuators.

PROCTER BROTHERS (WIREWORKS), Ltd., Castle Works, Caerphilly, Glam.—Catalogue of machinery guards.

REMPLOY, Ltd., 25/28, Buckingham Gate, S.W.1.—Leaflet describing the "Lundia" prefabricated wooden shelving system.

A.E.G. ELECTRIC COMPANY, Ltd., 131, Victoria Street, London, S.W.1.—List U.48, self-exciting and self-regulating alternators.

HILGER AND WATTS, Ltd., 98, St. Pancras Way, Camden Road, London, N.W.1.—Catalogue CH 387 describing equipment used for excitation of spectra for spectrochemical analysis by emission methods and also the Gramont Arc and Spark stand and controlled source units.

A. REYROLLE AND CO., Ltd., Hebburn, Co. Durham.—Revised publications : Pamphlet No. 469, "Automatic and Hand-Trimmed Semaphore Indicators" ; Pamphlet No. 783, "Sine Wave Alternator Sets" ; Pamphlet No. 1132, "Glass-G.A. Flameproof Air-Break Products" ; Pamphlet No. 1213, "Type 'TJG' Biased Induction Relays" ; Pamphlet No. 1258, "Series B Auxiliary Relays" ; Pamphlet No. 1273, "Type 'L42T' Vertical Isolation Switchgear for Service up to 750MVA and 33kV."

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

BRITISH INSTITUTION OF RADIO ENGINEERS

Thurs., Jan. 20th.—SCOTTISH SECTION : Department of Natural Philosophy, The University, Edinburgh, "Modern Ship-to-Shore Communication," G. Macdonald, 7 p.m.

Wed., Jan. 26th.—LONDON SECTION : School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "A Survey of Tuner Designs for Multi-Channel Television Reception," D. J. Fewings and S. L. Fife, 6.30 p.m.

CHEMICAL SOCIETY

To-day, Jan. 14th.—BIRMINGHAM BRANCH : The University, Birmingham, "The Structures of Electron-Deficient Substances," H. C. Longuet-Higgins, 4.30 p.m.——SOUTHAMPTON BRANCH : The University, Southampton, "Fission Products," P. E. Carter, 7 p.m.

Thurs., Jan. 20th.—TILDEN LECTURE : Large Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7, "The Role of the π-Electron in Aromatic Chemistry," H. C. Longuet-Higgins, 7.30 p.m.

Fri., Jan. 21st.—CAMBRIDGE SECTION : Chemical Laboratory, The University, Cambridge, "Recent Advances in Acetylene Chemistry," R. A. Raphael, 8.30 p.m.

DIESEL ENGINE USERS ASSOCIATION

Thurs., Jan. 20th.—Caxton Hall, Westminster, London, S.W.1, "Life Tests on a Small High-Duty Engine with Particular Reference to Chrome Bores," B. W. Millington, 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Tues., Jan. 18th.—GLOUCESTER AND CHELTENHAM CENTRE : The General Electric Company, Ltd., 2, St. Aldate Street, Gloucester, "Modern Trends in Picture Presentation," F. W. Capbell, 6.30 p.m.——LIVERPOOL CENTRE : Liverpool Engineering Society, 9, The Temple, 24, Dale Street, Liverpool, "The Application of Light in Medicine," 6.30 p.m.

Wed., Jan. 19th.—N. LANCASHIRE GROUP : N.W. Electricity Board, 19, Friargate, Preston, "Lighting for Enjoyment," T. O. Freeth, 7.15 p.m.——TEES-SIDE GROUP : Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, "The Applications and Maintenance of Discharge Lamp Installations," J. J. French, 6.30 p.m.

Thurs., Jan. 20th.—MANCHESTER CENTRE: N.W. Electricity Board, Town Hall, Manchester, "Lighting or Decoration," P. Cory and A. E. Hurst, 6 p.m.

INCORPORATED PLANT ENGINEERS

Tues., Jan. 18th.—S. WALES BRANCH : S. Wales Institute of Engineers, Park Place, Cardiff, "General Hydraulics," F. H. Fowler, 7.15 p.m.

Wed., Jan. 19th.—KENT BRANCH : Bull Hotel, Rochester, "Industrial Space Heating," J. Evans, 7 p.m.——WESTERN BRANCH : Grand Hotel, Bristol, "Space Heating and the Plant Engineer," T. H. F. Holman, 7.15 p.m.

Thurs., Jan. 20th.—BLACKBURN BRANCH : Golden Lion Hotel, Blackburn, "An Introduction to Atomic Energy," J. A. Dixon, 7.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Tues., Jan. 18th.—SLOUGH SECTION : Lecture Theatre, High Duty Alloys, Ltd., Slough, Film, "Design for Aluminium," 7.30 p.m.

INSTITUTE OF FUEL

Tues., Jan. 18th.—MIDLAND SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, "Locomotive Testing : with Special Reference to Fuel Economy," D. R. Carling, 6 p.m.

Wed., Jan. 19th.—YORKSHIRE SECTION : Royal Victoria Station Hotel, Sheffield, "The Investigation of Fluid Flow Problems by Model Techniques," F. A. Gray and A. D. Robertson, 2.30 p.m.

Thurs., Jan. 20th.—Institution of Civil Engineers, Great George Street, London, S.W.1, Discussion on "The Beaver Report," opened by G. E. Foxwell, 5.30 p.m.

Fri., Jan. 21st.—SCOTTISH SECTION : Royal Technical College, Glasgow, "The Recovery of Sulphur from Coke-Oven Gas by the Collin Process," T. H. Williams, 7 p.m.

INSTITUTE OF MARINE ENGINEERS

Mon., Jan. 17th.—STUDENTS LECTURE: 85, Minories, London, E.C.3, "Deck Machinery," W. H. Booth, 6.30 p.m.

INSTITUTE OF METALS

Mon., Jan. 17th.—SHEFFIELD LOCAL SECTION : The University Buildings, St. George's Square, Sheffield, "Metallurgical Research in the Electrical Industry," Ivor Jenkins, 7.30 p.m.

INSTITUTE OF PETROLEUM

Wed., Jan. 19th.—STANLOW BRANCH : Grosvenor Hotel, Chester, Annual General Meeting, "The Outlook for the Oil Industry," G. P. Glass, 7 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Wed., Jan. 19th.—N.W. CENTRE : Adelphi Hotel, Liverpool, "A New Paper on Carburation," L. J. Spencer, 7.30 p.m.

Thurs., Jan. 20th.—LONDON CENTRE : Royal Society of Arts, John Adam Street, London, W.C.2, "Accidents : Their Causes and Prevention," G. Mackenzie Junner, 6 p.m.——YORKSHIRE CENTRE : Hotel Metropole, King Street, Leeds, "Thin Wall Bearings," P. T. Holligan, 7.30 p.m.

INSTITUTE OF WELDING

To-day, Jan. 14th.—EAST OF SCOTLAND BRANCH : Technical College, Dundee, "Some Factors Affecting the Costs of Welding," W. Waller, 7 p.m.

Thurs., Jan. 20th.—E. MIDLANDS BRANCH : College of Commerce and Technology, Leicester, "Automatic Arc Welding," A. Bean and E. T. J. Harbron, 7.15 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Jan. 18th.—Geological Society, Burlington House, Piccadilly, London, W.1, "Performance Data for Expanded Metal Column Packing," H. R. C. Pratt and J. A. McWilliams, and "The Mechanism of Drop Formation from Gas or Vapour Bubbles," F. Kneimann, N. Dombrowski and D. M. Newitt, 5.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Jan. 18th.—Great George Street, Westminster, London, S.W.1, "New Northam Bridge, Southampton," F. L. Wooldridge, John Cuerel and K. R. Hauch, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Tues., Jan. 18th.—MEASUREMENTS SECTION : Savoy Place, London, W.C.2, Discussion on "The Human Operator in Closed Loop Control Systems," opened by C. Holt Smith, 5.30 p.m.——N. MIDLAND CENTRE : British Electricity Authority, 1, Whitehall Road, Leeds, 1, "Safety in the Use of Portable and Transportable Electrical Equipment in Industry," J. W. Bunting, 6.30 p.m.——S.E. SCOTLAND SUB-CENTRE : Carlton Hotel, North Bridge, Edinburgh, "Some Design Features of the Semi-Outdoor Power Station at Ince," F. H. S. Brown, 7 p.m.

Wed., Jan. 19th.—EDUCATION DISCUSSION CIRCLE : Savoy Place, London, W.C.2, Discussion on "Education and Training for Engineers and Craftsmen in France," opened by R. G. Bellamy, 6 p.m.——S.W. SCOTLAND SUB-CENTRE : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Some Design Features of the Semi-Outdoor Power Station at Ince," F. H. S. Brown, 7 p.m.

Thurs., Jan. 20th.—UTILIZATION SECTION: Savoy Place, London, W.C.2, "Design, Performance and Application of Miniature Circuit Breakers," H. W. Wolff and T. G. F. Atherton, 5.30 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Wed., Jan. 19th.—YORKSHIRE BRANCH : Midland Hotel, Bradford, "Recent Developments in Rolling Type Gear Testers," J. Horne, 8 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE

Tues., Jan. 18th.—Babcock and Wilcox, Ltd., Salisbury Square, London, E.C.4, Exhibition of Films, "Craftsman Welders" and "Steam for Power," 6.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Mon., Jan. 17th.—University College, Dundee, "Experiences in the Stabilisation of Ships," Sir William Wallace, 7.15 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Jan. 14th.—1, Birdcage Walk, Westminster, London, S.W.1, James Clayton Lecture, "The Theory of Plasticity : Recent Achievements and Future Problems," William Prager, 5.30 p.m.——SCOTTISH BRANCH : North British Hotel, Princes Street, Edinburgh, "Cutting Tool Research in the U.S.A.," Alex W. J. Chisholm, 7.30 p.m.

Tues., Jan. 18th.—STEAM GROUP : 1, Birdcage Walk, Westminster, London, S.W.1, "Modern Trends in Controls for Boiler Plants," Group Discussion, 6.45 p.m.——WESTERN BRANCH : Grand Hotel, Bristol, Address by A. B. Cooper, 7 p.m.

Wed., Jan. 19th.—E. MIDLANDS GRADUATES' SECTION : Little Theatre, Dover Street, Leicester, "Modern Methods of Balancing Machines," E. P. Fowler, 7.15 p.m.

Thurs., Jan. 20th.—N.W. BRANCH : Engineers' Club, Albert Square, Manchester, "Inspection, Explosion and Breakdown of Boilers and Pressure Vessels," J. Eyers, 6.45 p.m.

Fri., Jan. 21st.—1, Birdcage Walk, Westminster, London, S.W.1, Thomas Lowe Gray Lecture, "Some Factors in the Selection of Machinery for Cargo Liners," L. Baker, 5.30 p.m.——YORKSHIRE BRANCH : The University, St. George's Square, Sheffield, James Clayton Lecture, "The Theory of Plasticity : Recent Achievements and Future Problems," William Prager, 6.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Tues., Jan. 18th.—SCOTTISH BRANCH : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "A Graphical Approach to the Design of Two and Three-Span Rigid Frame Buildings," Hugh Fraser and W. G. Cantlay, 7 p.m.

Wed., Jan. 19th.—YORKSHIRE BRANCH : Great Northern Hotel, Leeds, "The Construction of the Woodhead New Tunnel," F. A. Charman, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Jan. 14th.—ORDINARY MEETING : Pepys House, 14, Rochester Row, London, S.W.1, "An Assembly Line and Materials Handling Technique in the Production of Heavy Vehicles," W. J. Kease, 7 p.m.

Fri., Jan. 21st.—INFORMAL MEETING : Pepys House, 14, Rochester Row, London, S.W.1, "Delegation of Responsibility and Authority," A. S. Trollip, 7 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, Jan. 14th.—Mining Institute, Newcastle upon Tyne, "Gas Turbine Combustion Systems," I. G. Bowen and W. Tipler, 6.15 p.m.

REINFORCED CONCRETE ASSOCIATION

Wed., Jan. 19th.—11, Upper Belgrave Street, London, S.W.1 "Reinforced Concrete in Coast Protection Works," J. A. Lewis, 6 p.m.

ROYAL AERONAUTICAL SOCIETY

Tues., Jan. 18th.—SECTION LECTURE : 4, Hamilton Place, London, W.1, "Manufacture of Integral Structures," E. G. West, 7 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Tues., Jan. 18th.—12, Great George Street, London, S.W.1, "Development Plans : Objects and Objections," Michael E. Rowe, 5.30 p.m.

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS

Mon., Jan. 17th.—The University, St. George's Square, Sheffield, "Metallurgical Research in the Electrical Industry," I. Jenkins 7.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Tues., Jan. 18th.—BIRMINGHAM AND MIDLAND SECTION : Room No. 8 (Cinema), Birmingham and Midland Institute, Paradise Street, Birmingham, "The Inhibition of the Attack of Metals by Acids," T. P. Hoar, 6.30 p.m.

Thurs., Jan. 20th.—ROAD AND BUILDING MATERIALS GROUP : Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "Plastics in the Building Industry," Y. W. Rayden, 6 p.m.

SOCIETY OF INDUSTRIAL ENGINEERS

To-day, Jan. 14th.—The George Hotel, Church Lane, London, N.W.9, "What is Your Problem ?" General Discussion, 7 p.m.

WOMEN'S ENGINEERING SOCIETY

Tues., Jan. 18th.—MANCHESTER BRANCH : Engineers' Club, Albert Square, Manchester, "The History and Development of Manchester Waterworks," D. F. Leach, 6.45 p.m.